OPERATING AND SERVICE MANUAL

100P
STRAIN
INDICATOR

BLH ELECTRONICS, INC.
A subsidiary of Baldwin • Lima • Hamilton Corporation
WALTHAM, MASSACHUSETTS 02154 • (617) 894-6700

TM-100P-1

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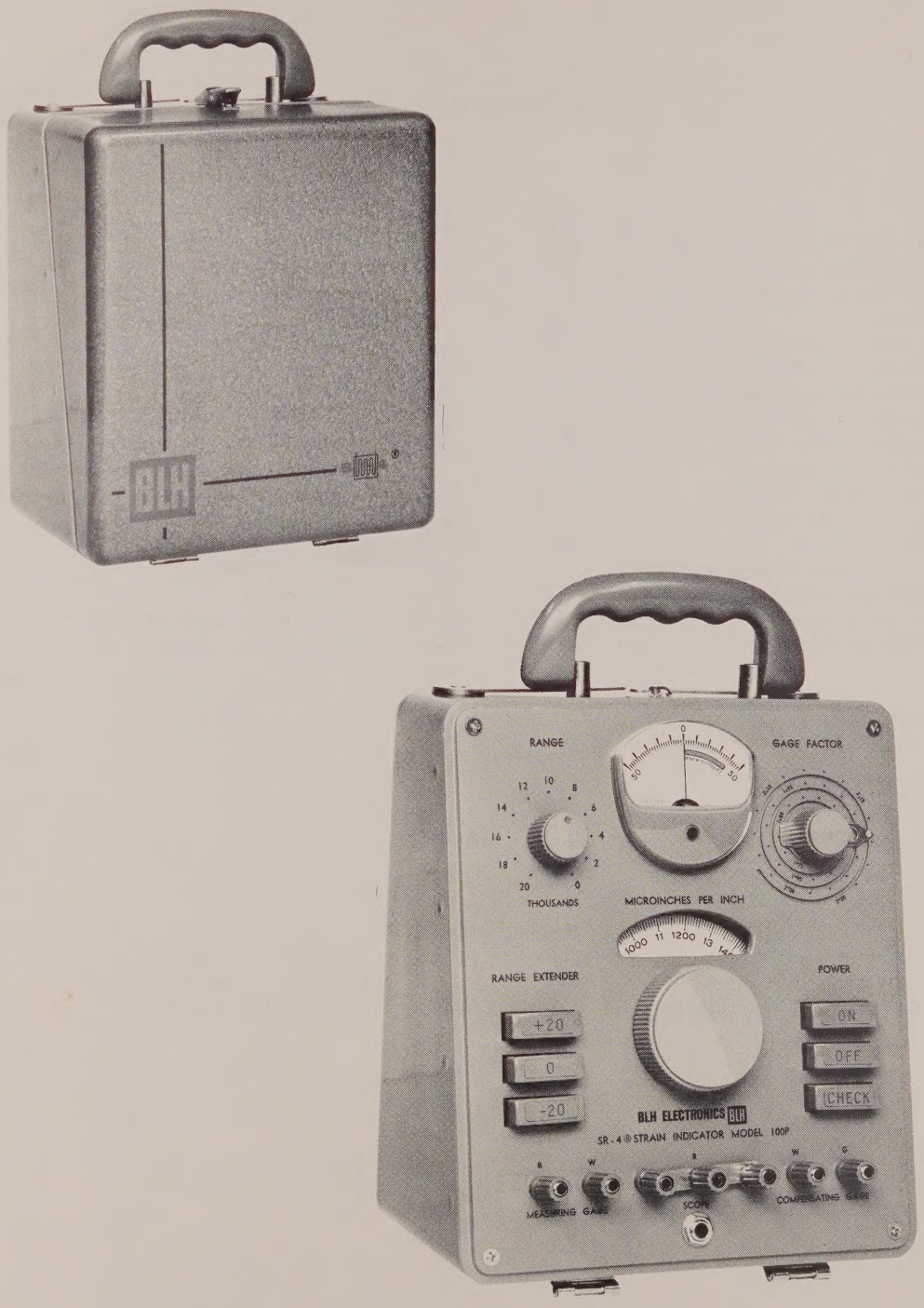

Figure 1-1. Model 100P Strain Indicator

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. General Description.

1-3. The Model 100P Strain Indicator is a portable solid state instrument designed to read the output of one, two, or four strain gages with a resistance of 60-500Ω and a gage factor of 1.77 to 2.20. Strain is read directly in microinches per inch. The major difference between the Model 100P and earlier BLH Strain Indicators is a 2000 Hz square wave oscillator. This oscillator provides the carrier excitation for the strain gage circuits and the internal phase demodulator, minimizing the effect of capacitance in long cables and improving the readability of low level signals.

1-4. The indicator may be used in field or laboratory applications depending upon the model ordered. The 100PB is a battery operated unit suitable for short run laboratory tests or field use. The 100PA is an ac operated instrument for laboratory use only. The Model 100PS/P Conversion Kit, available as an accessory, is used to convert the Model 100PB to ac operation. In certain rare cases where it is desirable to convert from ac to battery operation, contact your nearest BLH Sales/Service Office for the necessary instructions and parts.

1-5. Specifications.

1-6. Specifications which apply to the Model 100P are listed in Table 1-2. Specifications for the 100PA and 100PB are the same with the exception of the power supply. Power supply specifications for both models are also listed in Table 1-2.

1-7. Other Information.

1-8. The Model 100P is provided with two swing-out legs to permit tilting of the instrument for easier readability. Each instrument also contains a strain calculation formula (on bottom of case) and a simplified instruction sheet (inside cover). Both Data Sheets list the exact value of the range extender capability for the individual instrument.

1-9. ACCESSORY EQUIPMENT.

1-10. Model 625 Precision Calibrator.

1-11. The Model 625 Precision Calibrator, Figure 1-2, provides fifty-five extremely accurate millivolt per volt output signals to check instrumentation associated with strain gages, millivolt sensors or transducers. The unit is substituted for the transducer or gages and the readout is then verified. Instrument accuracy is determined without the need to remove and substitute temporary indicators and amplifiers for tests.

1-12. Model 100PS/P Conversion Kit.

1-13. The Model 100PS/P Conversion Kit, available as an accessory, makes it possible to convert the Model 100PB to a Model 100PA. The conversion kit comes supplied with a solid state power supply, power cord, connectors and all necessary hardware. Complete conversion instructions are provided with each kit.

1-14. Model 250 Calibration Check Unit.

1-15. The BLH Model 250 Calibration Check Unit is essentially a half bridge circuit used to simulate an active and compensating gage. The potentiometer tap switch has a range of 0-20,000 micro inches per inch, graduated in 10 steps of 2000 ohms each. The gage resistance is 120 ohms with a gage factor of 2.00.

Table 1-1. Accessory Equipment

ITEM	USE	BLH NO.
Model 625 Precision Calibrator	Performance Check/Trouble shooting/Calibration	203797-3
Model 100 PS/P Conversion Kit	Conversion of Model 100PB Strain Indicator to AC Operation	401545-1
Model 250 Calibration unit	Calibration	103144

Table 1-2. Model 100P Specifications

RANGE:

DIAL: 0 to 2,000 microinches per inch.

INITIAL LOAD SWITCH: consists of ten 2,000 microinch per inch steps. (The tolerance in each step is ±2.5 microinches per inch).

RANGE EXTENDER SWITCH: 20,000 ±50 microinches per inch in tension and compression. (The exact value is listed on data sheets on bottom of case and in cover).

GAGE FACTOR: 1.77 to 2.2. (Used as a correction for strain gage sensitivity factor variation).

ACCURACY: (Based on gage factor setting of 2.00).

REFERENCE SWITCH: ±2.5 microinches per inch per step (errors are not cumulative).

RANGE EXTENDER SWITCH: ±10 microinches per inch of indicated value.

DIAL: ±3 microinches per inch.

GAGE FACTOR DIAL: ±0.25%.

DIAL READABILITY: 2 microinches per inch.

METER SENSITIVITY: 30 to 70 microinches per inch for full scale deflection.

ZERO DRIFT: negligible.

INPUT: 1, 2, or 4 arm strain gage networks.

AMBIENT TEMPERATURE RANGE: 50° F to 150° F (10° C to 66° C); error is less than 2 microinches per inch in 500 microinches per inch for 60° F (33° C) ambient temperature range.

RESISTANCE OF STRAIN GAGES: 60 to 500 ohms.

WEIGHT: 10 pounds. (4.5 kg)

SIZE: 10" H x 9" W x 6-1/4" D (254 x 228 x 159 mm)

POWER REQUIREMENTS:

MODEL 100PA: complete with self-contained power supply in battery compartment. 115V ±10%, 50-60 cps, 10W; grounded terminal furnished on AC plug; 24V dc output.

MODEL 100PB: two standard commercial batteries (Mallory #TR-289 or equiv.) 12.6 volts; two required.

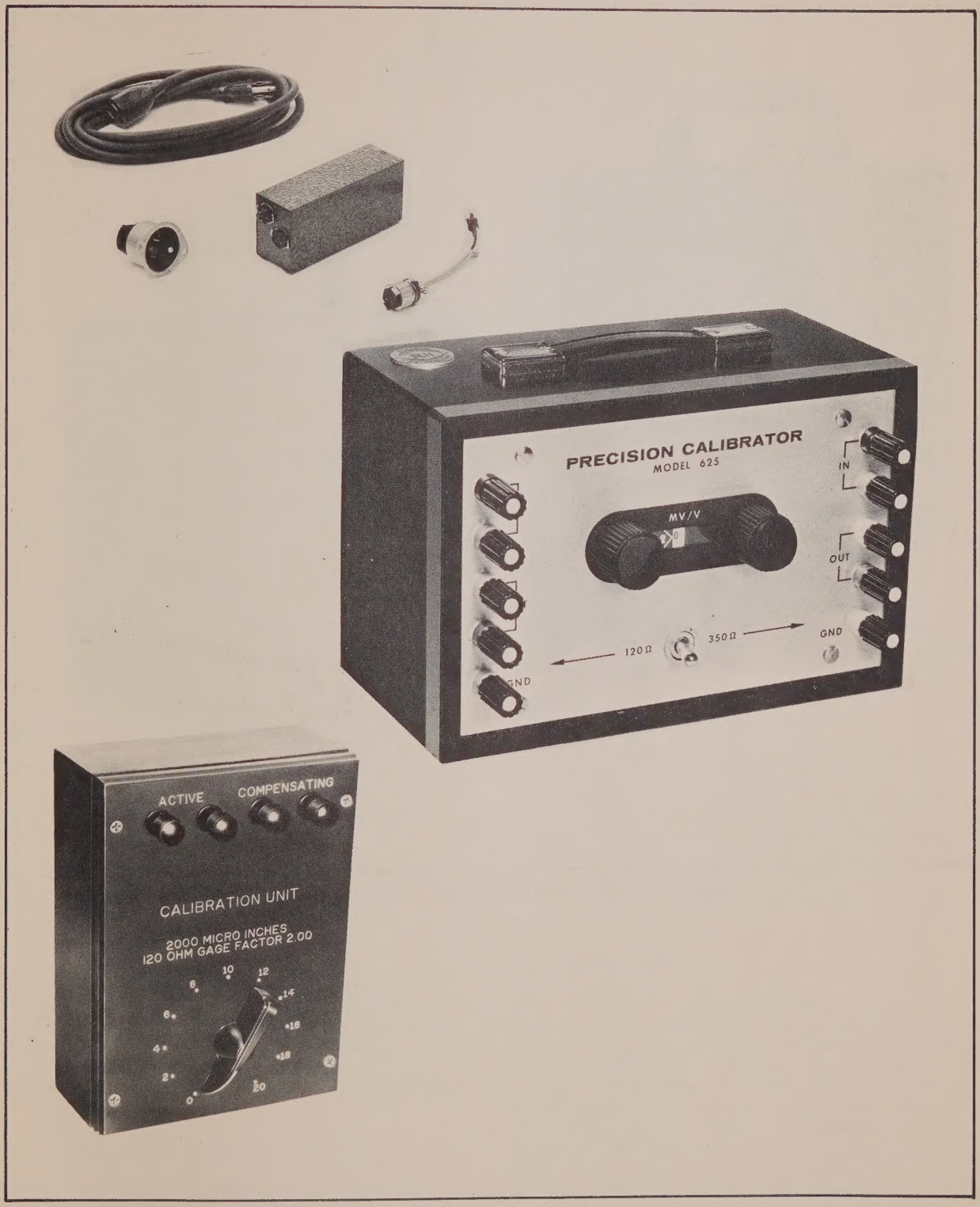

Figure 1-2. Accessory Equipment

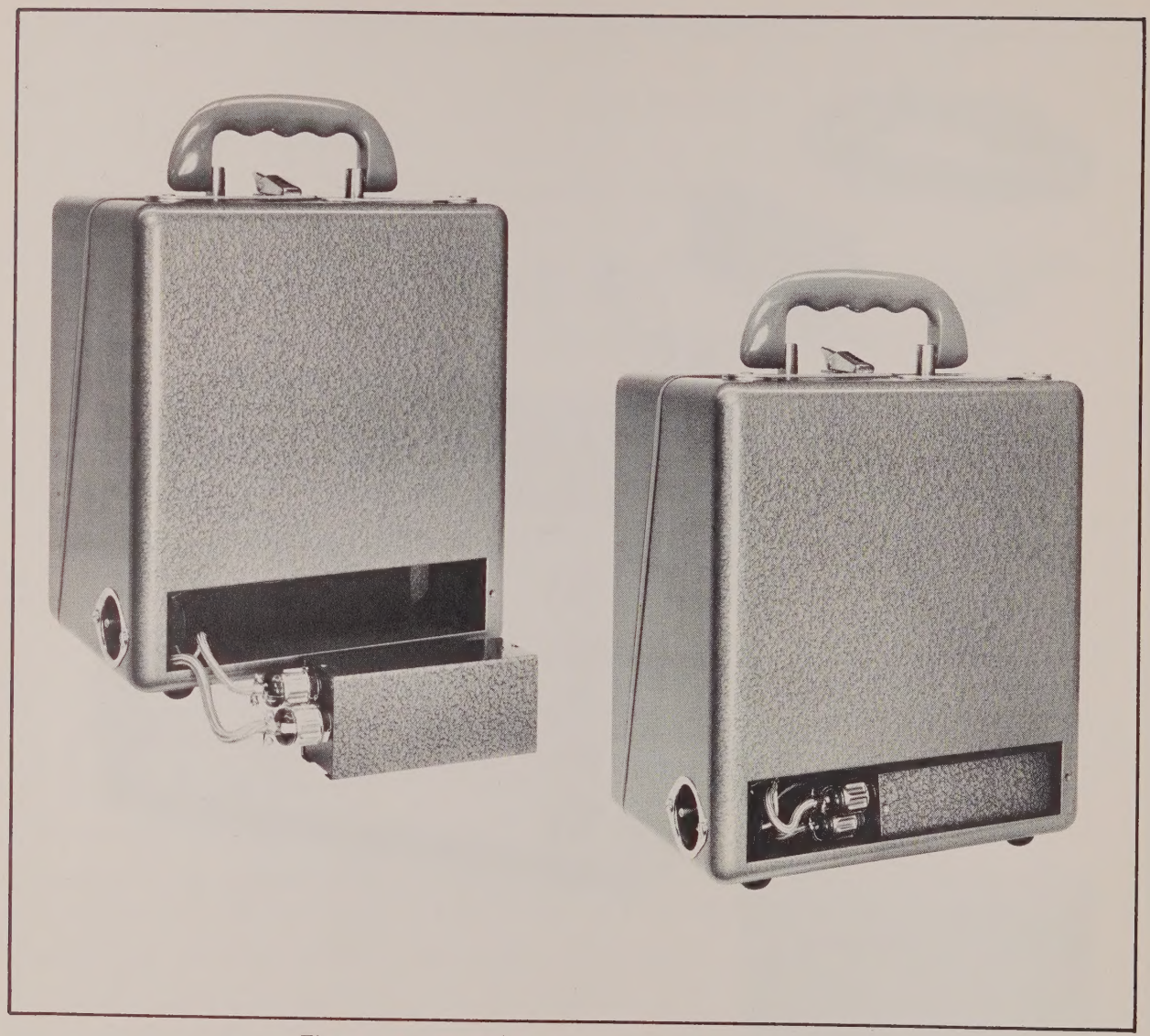

Figure 1-3. 100 PS/P Conversion Kit After Installation

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information on unpacking, inspection, repacking, and installation.

2-3. INITIAL INSPECTION.

2-4. Mechanical Inspection.

2-5. If external damage to the shipping carton is evident, ask the carrier's agent to be present when the instrument is unpacked. Check the unit for external damage such as broken controls or connectors, and dents or scratches on the panel surface. If damage is found, refer to Paragraph 2-8 for recommended claim procedure and repacking information. If the shipping carton is not damaged, check the cushioning material and note any signs of severe stress as an indication of rough handling in transit. Retain the packaging material for possible future use.

2-6. Electrical Check.

2-7. Check the electrical performance of the instrument as soon as possible after receipt; see Maintenance, Section V of this manual, for the recommended performance checks. The checks will verify that the unit is operating within the specifications listed in Section I. This check is a good test procedure for incoming quality control inspection and for an operational check after repairs or adjustments have been made.

2-8. CLAIMS AND REPACKAGING.

2-9. Claims for Damage.

2-10. If physical damage is evident or if the instrument does not meet specifications when received, notify the carrier and the nearest BLH Sales/Service Office (see list in back of manual). The Sales/Service Office will arrange for repair or replacement of the unit without waiting for settlement of the claim against the carrier.

2-11. Repacking for Shipment or Storage.

2-12. If the instrument is to be shipped to a BLH Sales/Service Office, or to the factory, attach a tag showing owner, address, instrument model and serial number, and the repair required. The original shipping carton and packaging material may be reusable. The BLH Sales/Service Office will also provide information and recommendations on materials to be used if the original packaging material is not available or not reusable. Materials should include, (1) a double-walled carton (check with a freight carrier for test strength required), (2) heavy paper or sheets of cardboard to protect all instrument surfaces; use extra material around projecting parts of the instrument, (3) at least four inches of tightly packed, shock absorbing material surrounding the instrument. Close the package securely with heavy paper tape.

2-13. INSTALLATION.

2-14. Location.

2-15. The selection of a suitable location for the Indicator is important for satisfactory operation. Ideally, the instrument should be located in a clean, dry room with a uniform temperature. Avoid locations where temperatures are above 100° F or below 32° F.

2-16. Power Requirements.

2-17. The Model 100PA is designed to operate with a line voltage of 115 Vac 50-60 Hz at 10 watts. The Model 100PB is supplied with two 12.6 volt mercury activator batteries which provide instrument power. Batteries should be replaced whenever indicated (see Section III, Instrument Self-check) The power supplies for both the Model 100PA and the Model 100PB are located in the compartment at the rear of the instrument.

2-18. Power Cable.

2-19. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. The Model 100PA is equipped with a 10 foot, 3 conductor power cable; the third conductor is the ground conductor, and when the instrument is plugged into an appropriate receptacle, the instrument is grounded. The offset pin on the power cable three-prong connector is the ground connection. The other end of the cable is connected to the receptacle on the lower right side of the instrument.

1. RANGE:

Shifts the reference point of the balancing dial by 2,000 microinches-per-inch for each step of the switch. The position of the RANGE switch corresponding to 10,000 microinches-per-inch (10 on indicator) is the zero of the indicator. This allows an additional operating range of 10,000 microinches-per-inch.

2. BALANCING CONTROL:

Controls the slide wire and balancing dial. When the control is rotated, it shifts the output voltage balance of the strain gage bridge and the measuring circuit. When exact balance occurs, the null meter indicates zero.

Figure 2-1. Front Panel Control Data

3. RANGE EXTENDER:

Extends the balancing range beyond that covered by the RANGE switch. Normally, it is used only when the active and compensating gages are very poorly matched in resistance and occasionally when very large strains are measured.

4. SCOPE:

Permits oscilloscopic observation of dynamic strains.

5. NULL METER:

Indicates a balance between the strain gage bridge output and the measuring circuit voltage. When the balancing control is rotated and the meter nulled at zero, the strain gage bridge output voltage equals the measuring circuit voltage. This meter has an approximate range of 50-0-50 microinches per inch.

6. GAGE FACTOR:

The gage factor control is graduated from 1.77 to 2.20 and when set to the factor corresponding to that on the gage in use, applies the proper voltage to the measuring circuit.

7. BALANCING DIAL:

This dial, in conjunction with the RANGE switch, is used to indicate the magnitude of the strain. When the null meter is balanced, this balancing dial reading is added to the range switch setting. The meter graduations are 10 microinches per inch per division.

8. POWER:

This switch controls the power to the indicator. The CHECK button is used to check battery or ac power supply voltage. When the CHECK button is depressed, the NULL meter pointer should deflect to the right and past the red area. For normal operation, depress the ON button.

9. BINDING POSTS:

These terminals are used to connect the gages or transducer to the instrument.

Figure 2-1. Front Panel Control Data (cont'd.)

2-20. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green lead on the adapter to ground.

2-21. Strain Gage Connections.

2-22. Strain gages are connected to the binding posts located on the front panel. See Section III of this manual for a full explanation of the various configurations possible and connection instructions.

2-23. Strain gage extension leads should have a low, stable resistance and a minimum temperature coefficient. The leads should be coated with an insulating material that is equivalent to the insulating quality of the gage carrier and bonding cements used. The following materials have been found suitable for BLH strain gage use:

Conductors:

a. nickel-clad copper, 700° - 1000° F
b. stainless steel-clad copper, 800° - 1300° F
c. nickel clad silver, 1000° - 1500° F
d. nichrome, 700° - 1700° F

Insulators:

a. Nylon®, below - 100° F
b. vinyl, - 100° F - 150° F
c. polyethylene - 100° F - 500° F
d. Teflon®, -100° F - 500° F
e. glass impregnated silicone, above 500° F
f. glass sleeving, above 500° F

For other than BLH strain gages, consult the manufacturer.

2-24. All gage lead extension wires should be soldered or welded to the gages depending upon the application and type of gage used. For binding post connections, lead extensions should be soldered to clean, tinned spade lugs. If stranded leadwire is used, all strands should be intact and care should be taken to solder all strands to the spade lug. In locations where strong electrical disturbances are present, shielded cable should be used for long extension leads. The shield should be grounded at only one point.

2-25. Lead Wire Resistance.

2-26. In most strain gage work, the effect of lead wire is negligible unless the leads are long and of a small diameter. In these applications, this resistance must be taken into account as lead wire resistance, in series with the strain gage, reduces the effective gage factor in proportion to the ratio of lead resistance to gage resistance. To correct this condition, it is necessary to reduce the gage factor setting on the instrument and is accomplished as follows:

Assume that a 120Ω strain gage, placed 50 feet from the instrument, has copper lead wires of #18 gage. The resistance of 18 gage copper is 6 ohms per 1000 ft., giving a total lead resistance of .6 ohms. Further assume that the compensating gage is placed close to, or at the instrument. The reduction in actual gage factor will be $\frac{0.6}{120}$ or 0.5%. If the true gage factor, as found on the gage package, is used, the indicated strains will be 0.5% low. Setting the gage factor on the instrument at 99.5% of the true gage factor will cause the instrument to automatically compensate for the lead wire resistance. If, however, the lead wire resistance exceeds 5% of the gage resistance, a more exact calculation is required.

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SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. Operation of the Model 100P is simplified by the sloping front panel and logical positioning of the controls. The swing out legs permit tilting of the instrument for maximum readability.

3-3. OPERATING NOTES.

3-4. Determining True Indicator Zero.

3-5. Errors in instrument zero may be eliminated by the following method:

a. Connect a 120Ω precision wire-wound resistor to the MEASURING GAGE terminals on the front panel of the indicator.

b. Connect a second 120Ω precision wire-wound resistor to the COMPENSATING GAGE terminals on the front panel and record the reading. Values of both resistances should be within .01% of each other. (119.9-120.1Ω)

c. Substitute the Compensating Gage resistor for the Measuring Gage resistor, balance the indicator and record the reading. The average of the two readings (the sum of the readings divided by 2) yields the indicator zero.

The indicator zero may be used to correct all strain readings to the same basis, and to take measurements during long tests. Measurement may also be taken on the same gages with different indicators without loss of accuracy.

NOTE: Two matched strain gages or two resistance decades meeting the specifications listed in Table 5-1, Section V of this manual may be substituted for the 120Ω resistors.

3-6. Measurements of Plastics and Metals in the Plastic Region.

3-7. To make measurements on plastics and metals in the plastic region, or to increase the range of the dial so that strain readings can be made without resorting to a change of the range switch, it is only necessary to introduce fixed wirewound resistors in the gage circuits as shown in Figure 3-1. The dial range can be increased appreciably by the use of

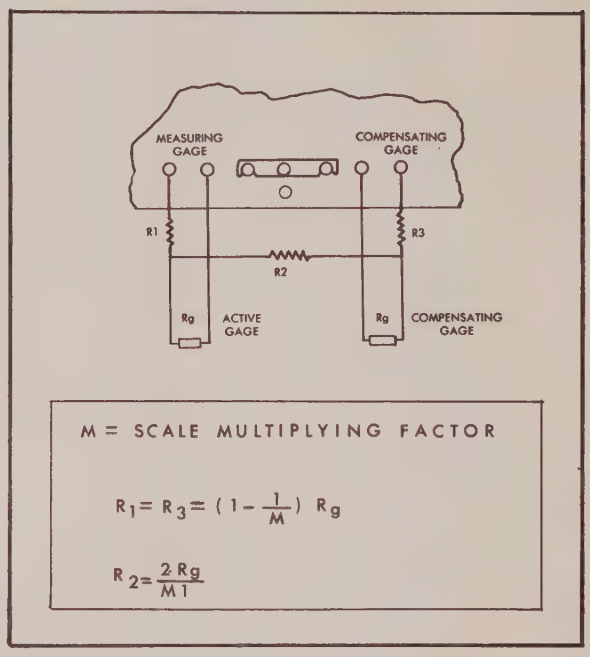


Figure 3-1. Increasing Dial Range

formulae. The resistors should all be non-inducive, precision wirewound, and accurate within ±0.25%.

3-8. Instrument Self-Check

3-9. Both the 100PA and 100PB Models of the Strain Indicator have been provided with a self-check feature. Perform the check as described in Figures 3-2 and 3-3 before operating the instrument.

3-10. CALIBRATION.

3-11. The Strain Indicator measuring circuits are constructed of highly stable fixed and variable wirewound resistors and should give long dependable service without recalibration. If, however, a component should fail and is replaced, or if for other reasons the calibration of the indicator is in doubt, it may be checked and recalibrated with a BLH Model 625 Calibrator. The BLH Model 250 Calibration Check Unit may also be used to check the accuracy of the indicator as shown in Figure 3-8.

NOTE: The calibration procedure described in Figure 3-7 is recommended only for minor adjustments. If

1. Connect the instrument to a 115 Vac power source.
2. Push the power CHECK button.
3. The null meter pointer should deflect to the right, past the red area.
4. If meter fails to move or stops in red area, check the power cable connections or the power supply. See Maintenance, Section V of this manual for specific instructions.

Figure 3-2. Model 100PA Self-Check

1. Push the power CHECK button.
2. The null meter pointer should deflect to the right, past the red area. If the pointer fails to move or stops in the red area, the batteries should be checked and, if necessary, replaced. See Maintenance, Section V of this manual for specific troubleshooting instructions.
3. Repeat check hourly if the indicator is used continuously. To conserve batteries always switch power OFF when not actually taking readings.

Figure 3-3. Model 100PB Self-Check

a major adjustment is required, it is suggested that the indicator be returned to the factory for calibration.

3-12. STRAIN MEASUREMENT.

3-13. The strain in the test specimen or transducer is read as the difference between the initial and final instrument RANGE, RANGE EXTENDER and DIAL READINGS. The operating procedures necessary to obtain these readings are explained in Figures 3-9 through 3-13. The calculations required to obtain the actual strain in micro inches per inch are detailed in Figure 3-14.

To read strain in gages other than 120Ω but between 50 and 500 ohms, it is necessary to correct the readings as shown below.

a. Choose an active and compensating gage with equal initial resistances within ± 1/2%.

b. If the gage factor lies between 1.77 and 2.20, determine the gage factor multiplier from Figure 3-4.

c. Multiply the gage factor of the gage by the multiplier from the curve. Set the new figure on the instrument as the gage factor.

d. If the gage factor is outside the 1.77-2.20 limits, set the gage factor dial at twice the multiplier found from the curve and multiply all indicated strains by the ratio shown below.

$$\frac{2.00}{\text{True gage factor (as shown on gage container)}}$$

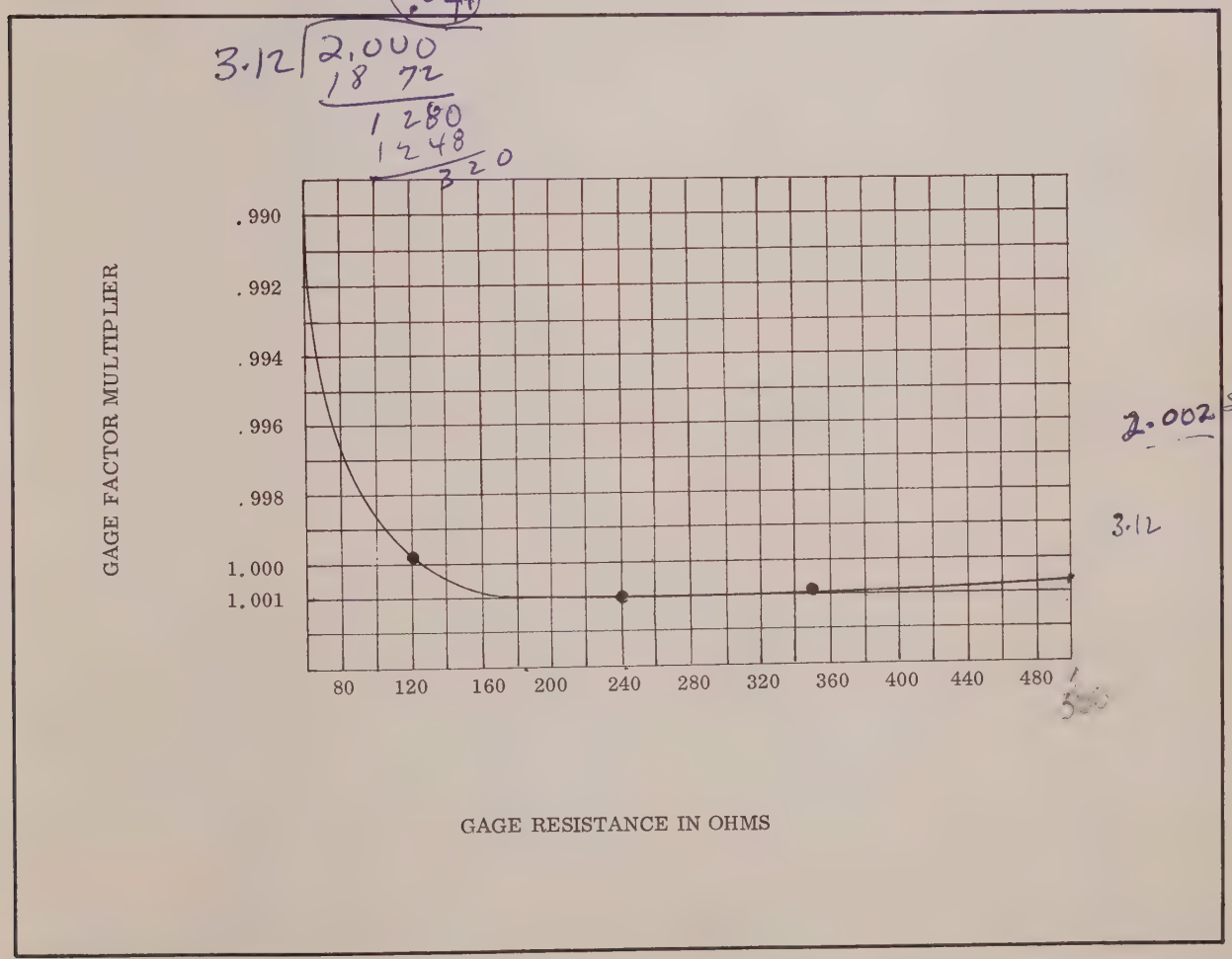


Figure 3-4. Correction Curve

3-14. Three Wire System With a Single Self-Compensated Gage.

3-15. Use of the self-compensated strain gage elimin ates the need for a compensation gage in most cases. To avoid lead wire induced errors it is recommended that the "three-wire" method of resistance measurement be used. To use the three-wire system with the Strain Indicator, connect the gage to the instrument as shown in Figure 3-5. The Resistor, R, should equal the gage G. Compute strain by the active/compensating gage method as described in Figure 3-9.

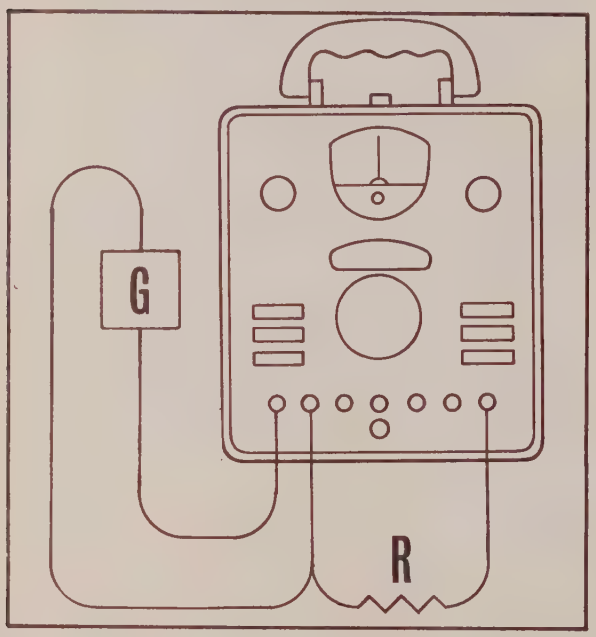


Figure 3-5. Three Wire Method

3-16. Connecting and Switching Multiple Self-Compensated Gages.

3-17. Figure 3-6 illustrates a practical arrangement for switching multiple self-compensated gages into the Model 100P strain indicator with the three wire system. The gages must be located in close proximity to one another in order to minimize the temperature effects on the difference in leadwire lengths.

3-18. Connect the gages to the instrument as shown in Figure 3-6. The value of the Resistor, R, should be equal to one of the gages, G. Switch S must have a low, constant, contact resistance. A high-quality three or four deck rotary switch, wired in parallel, is satisfactory and should give a reasonably long service life. Compute strain by the active/compensating gage method as described in Figure 3-9.

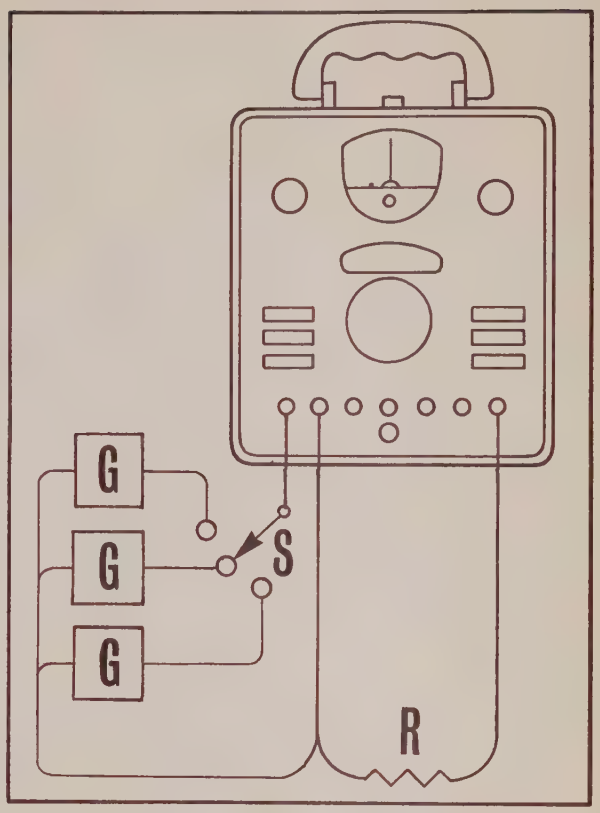


Figure 3-6. Switching Multiple Gages

NOTE: If multiple three-wire systems are used frequently, BLH recommends use of a precision switching unit designed especially for this type of application. The unit may be purchased through any of the BLH Sales/Service offices listed in the rear of this manual.

3-19. SPECIFIC APPLICATIONS.

3-20. Active and Compensating Gage.

3-21. To cancel the effects of temperature on the gage wire, a circuit like that shown in Figure 3-9 is used. This arrangement, a commonly used circuit in strain gage work, employs two gages as adjacent arms of the bridge. One of these gages, the "active" gage, is mounted on the test specimen. The compensating, or "dummy", gage is mounted on an unstressed piece of the same material. The two gages are located close together, so that both are subjected to substantially the same temperature.

3-22. If the two gages are identical, and if both are subjected to the same changes in temperature during the course of measurement, resistance changes due to

temperature alone will be the same for both of the Wheatstone Bridge arms in which these gages are located. The remaining two arms are located inside the indicator. The effects of temperature on the gages will have practically no influence on the measurement of the stress-induced strain at the active gage. The measurement will, however, include strain due to thermally-induced stresses in the metal. It is, therefore, a true measure of stress. The function of the "dummy" or compensating gage is to compensate for the undesired effects of temperature. See Figure 3-9 for specific operating instructions.

3-23. External Bridge Circuit.

3-24. In certain strain gage investigations, it is sometimes advantageous to connect the gages into a closed external bridge circuit as shown in Figure 3-12. This circuit minimizes the effects of variations in cable length and terminal contact resistance because both sources of error are external to the gage bridge.

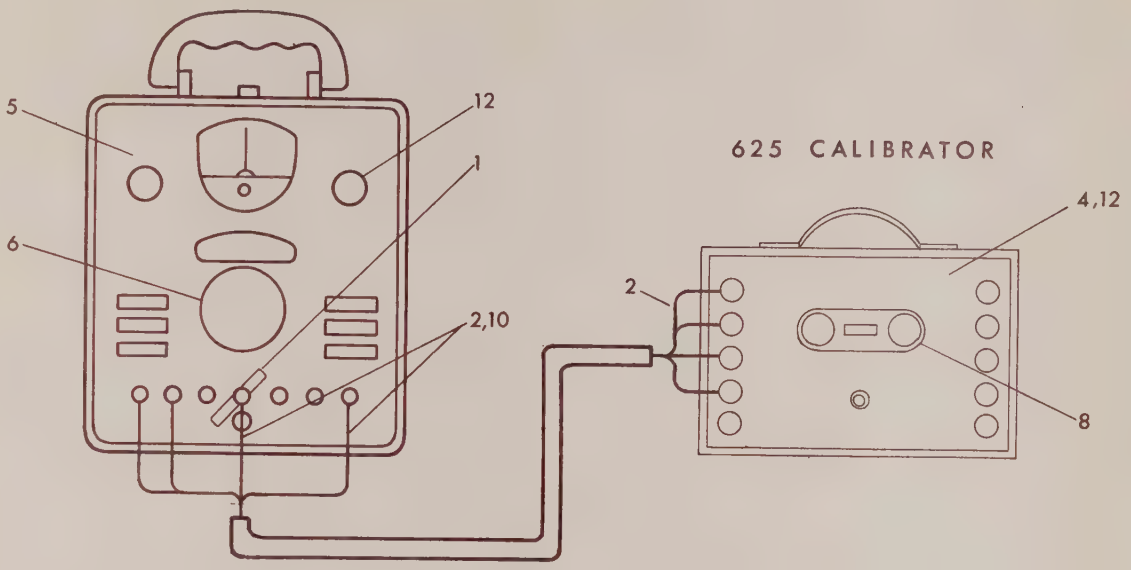
3-25. The external bridge also lends itself to realization of increased measuring sensitivity in cases where it is practical to employ two active and two compensating gages (connected alternately around the bridge loop). The indicated strain will then be just twice the actual strain since the two active gages will produce an additive effect in unbalancing the bridge. This arrangement has been used effectively where strains to be measured are very small. See Figure 3-10 for specific operating instructions.

3-26. Visual Indication of Dynamic Strain.

3-27. Although the Strain Indicator has been designed primarily for the measurement of static strains, provisions have been made for the observation of dynamic strains with an oscilloscope. Connect the oscilloscope to the SCOPE jack beneath Terminal R on the front panel of the indicator. If the magnitude of the strain to be observed is below 3500 microinches per inch, the indication is quantitative. Beyond 3500 microinches per inch, the amplifier of the indicator becomes non-linear, and must be corrected for as shown in Figure 3-1. The use of this simple circuit will permit proportionately larger dynamic-strains to be observed with good linearity.

3-28. Transducer Measurement.

3-29. The indicator may be used to measure the response of any load or pressure transducer in the BLH line. The bridge circuits of these cells are adjusted to a standard output and are all fully compensated for temperature. See Figure 3-11 for operating instructions.



Preliminary: Perform the instrument self-check as described in Figures 3-2/3-3 of this section before attempting this procedure

1. Open the jumper connection between Binding Post R and the two adjacent terminals.

2. Connect the terminals on the 120Ω side of the Calibrator to the indicator color for color. The indicator terminals are lettered B, W, R, and G to correspond to the color coded Calibrator terminals.

3. Connect the White lead to either of the W indicator terminals.

4. Set the Calibrator controls as follows:

Bridge selector switch	-	120Ω
Range switch	-	0-10
Step switch	-	0

5. Set the Indicator controls as follows:

GAGE FACTOR	-	2.00
RANGE	-	10
Power	-	ON

Figure 3-7. Calibration with Model 625 Calibrator

6. Rotate balancing dial knob in direction to bring meter pointer to zero. If the pointer cannot be brought to zero, leave balancing dial at end to which turned and set exactly at 0 or 2000.

   Attempt to bring pointer on scale by rotating RANGE switch. If pointer remains off scale to the right, push the RANGE EXTENDER "+ 20" button and set RANGE switch to zero. If off scale to the left, push RANGE EXTENDER "- 20" button and set RANGE switch to 20. Zero the meter.

7. Record dial and switch readings with the meter zeroed, i.e.

RANGE EXTENDER	RANGE	DIAL
0	16	1232

8. Set Calibrator STEP switch to the 1 mV/V position, rebalance indicator and record the reading. Repeat this procedure in 1 mV/V steps through 10 mV/V, recording the readings at the completion of each step.

9. When a series of readings from 0 to 2000 microinches per inch, in 2000 microinch per inch steps for each calibrator increment of 1 mV/V, has been obtained, compute each value as described in Figure 3-8.

10. Reverse the Black and Green leads at the Calibrator.

11. Repeat steps 4 through 9, above.

12. At 20,000 microinches per inch, the final computed readings should be within ± 50 microinches per inch of each other. If the difference is more than 50 microinches per inch but less than 100 microinches per inch, calibrate the indicator as follows:

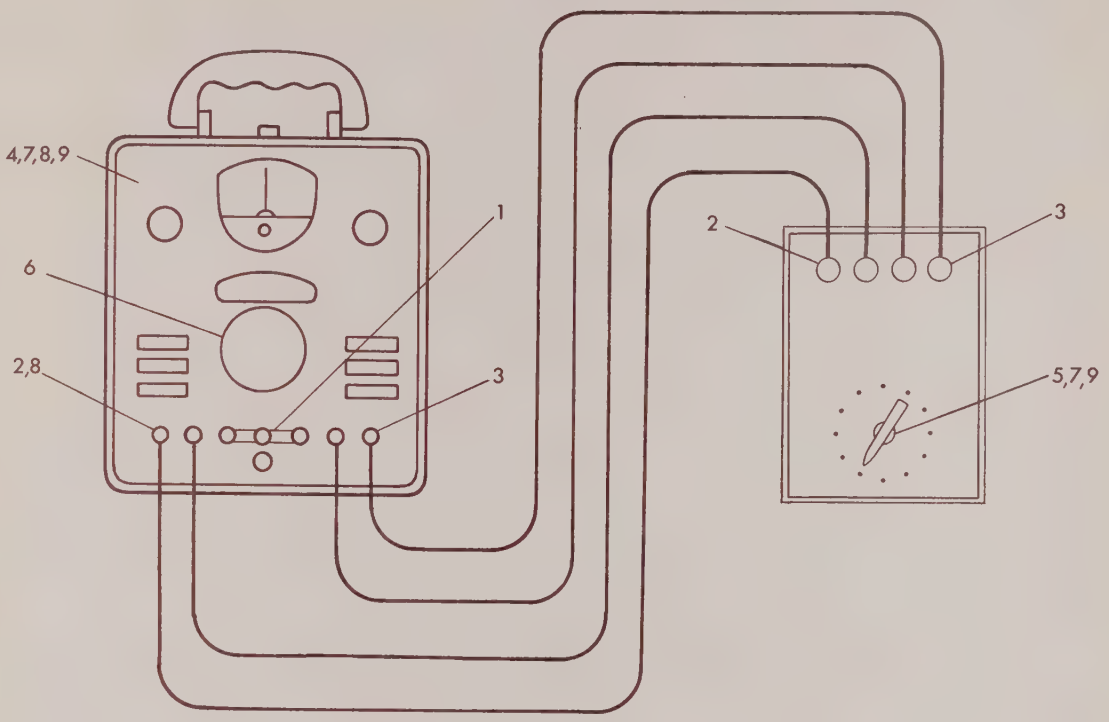
    a. Loosen set screws on GAGE FACTOR control and remove knob.

    b. With the Calibrator, apply the equivalent of 20,000 microinches per inch (10mV/V) strain.

    c. Rotate the shaft of the GAGE FACTOR potentiometer until the INDICATOR reads 20,000 microinches per inch.

    d. Set the pointer of the GAGE FACTOR control to exactly 2.00, replace the knob and tighten the set screws.

Figure 3-7. Calibration With Model 625 Calibrator (Cont'd.)



Preliminary: Perform the instrument self check as described in Figures 3-2/3-3 of this section before attempting this procedure.

1. CLOSE the jumper connection between binding post R and the two adjacent terminals.

2. Connect the B & W MEASURING GAGE terminals on the indicator to the ACTIVE terminals on the Calibrator

3. Connect the G & W COMPENSATING GAGE terminals on the indicator to the COMPENSATING GAGE terminals on the Calibrator.

Figure 3-8. Calibration Check with Model 250 Calibration Check Unit

4. Set the Indicator controls as follows:

RANGE EXTENDER	- 0
RANGE switch	- 10
Power	- ON
GAGE FACTOR	- 2.00

5. Set the Calibration unit to 0.

6. Balance the Indicator with the balancing knob. Record the reading.

7. Complete the following steps in the indicated order. Record the reading at each step.

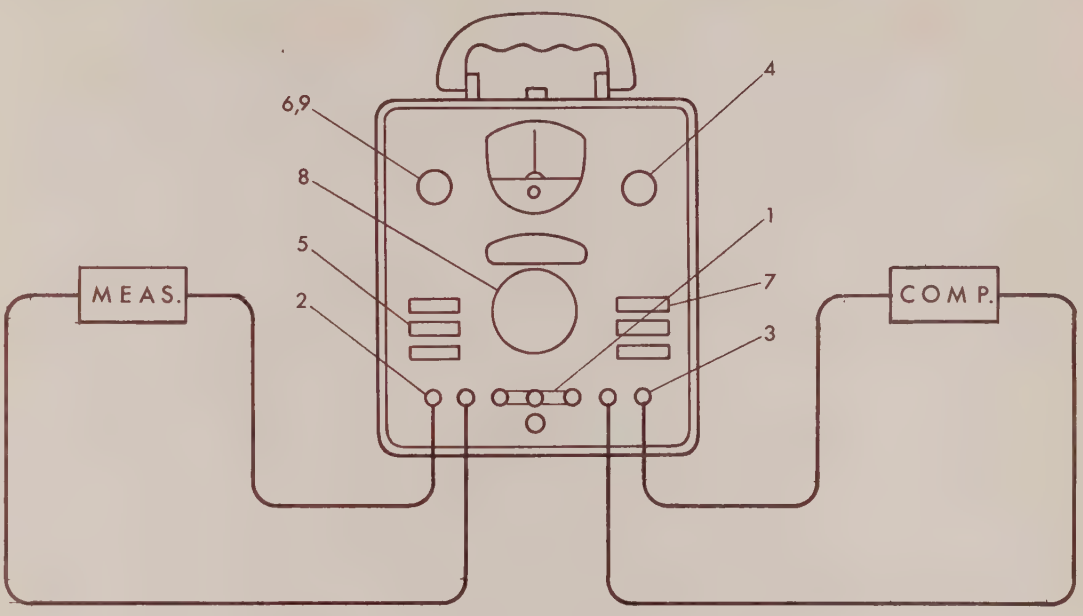
Calibration Check Unit Pos.	Ind. Switch Pos.
10	0
8	2
6	4
4	6
2	8
0	10

8. Reverse the B and G leads and rebalance the indicator with RANGE switch on 0.

9. Continue the calibration check in the indicated order, recording the reading at each step.

Calibration Check Unit Pos.	Ind. Switch Pos.
10	0
8	2
6	4
4	6
2	8
0	10

Figure 3-8. Calibration Check with Model 250 Calibration Check Unit (Cont'd)



Preliminary: Make instrument self-check as shown in Figures 3-2/3-3.

INTERCONNECTIONS:

1. CLOSE the jumper connection between terminal R and the two adjacent binding posts.

2. Connect the measuring or "active" gage to terminals B and W under MEASURING GAGE.

3. Connect the compensating or "dummy" gage to terminals G and W under COMPENSATING GAGE.

4. Set the GAGE FACTOR control to the exact value as marked on the gage package. Record setting for future reference.

5. Set RANGE EXTENDER to "0".

6. Set RANGE switch to 10.

7. Push ON button.

Figure 3-9. Operation for Measuring/Compensating Gage Circuit

STRAIN MEASUREMENT:

8. With gages in static condition, (no strain) rotate balancing knob in direction to bring meter pointer to zero. If pointer cannot be brought to zero, leave balancing dial at end to which turned and set exactly at 0 or 2000.

9. Attempt to bring pointer on scale by rotating RANGE switch. If pointer remains off scale to the right, push the RANGE EXTENDER "+20" button and set RANGE switch to zero. If off scale to the left, push RANGE EXTENDER "-20" button and set RANGE switch to 20. Zero the meter.

10. Record dial and switch readings with the meter zeroed.

RANGE EXTENDER	RANGE	DIAL
0	16	1232

FINAL READING:

11. Apply strain.

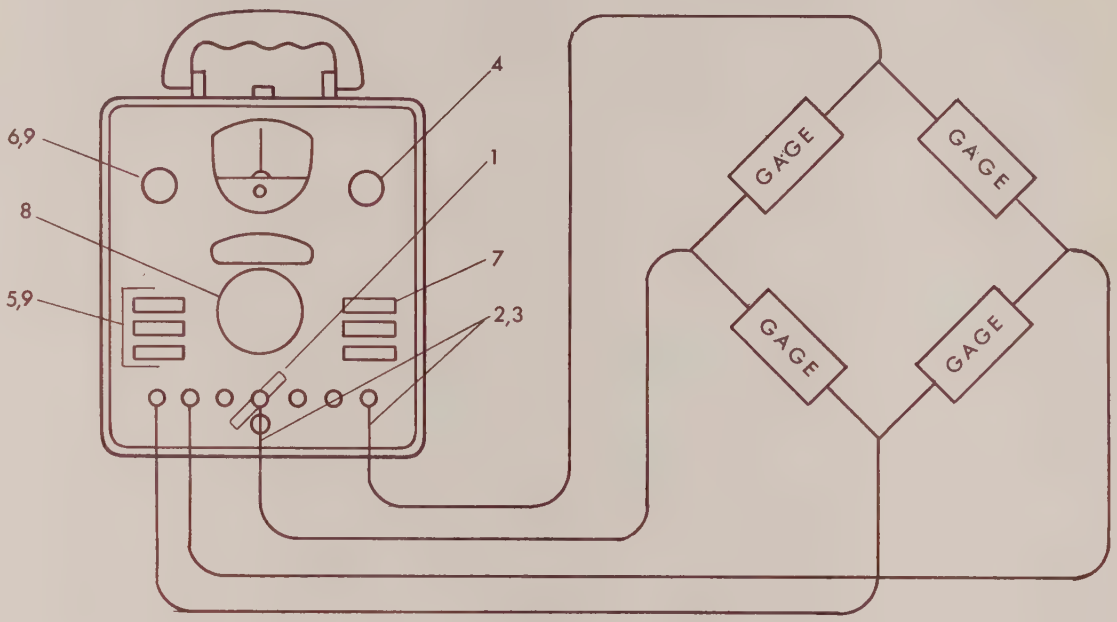
12. Repeat step 9.

13. Record final dial and switch readings with meter zeroed, i.e.:

RANGE EXTENDER	RANGE	DIAL
0	20	158

14. Calculate strain according to instructions in Figure 3-14.

Figure 3-9. Operation for Measuring/Compensating Gage Circuit



Preliminary: Make instrument self-check as shown in Figures 3-2/3-3.

INTERCONNECTIONS:

1. Open the jumper connection between terminal R and the two adjacent binding posts.

2. Connect the power input terminals of the external bridge to binding posts B & G.

3. Connect the bridge output terminals to binding post R and either of the white terminals.

4. Set the gage factor dial to the gage factor supplied with the gages.

5. Set RANGE EXTENDER on "0".

6. Set RANGE switch to 10.

7. Push ON button.

Figure 3-10. Operation for External Bridge Circuit

STRAIN MEASUREMENT:

Initial Reading:

8. With gages in static condition, rotate balancing dial knob in direction to bring meter pointer to zero. If pointer cannot be brought to zero, leave balancing dial at end to which turned and set exactly at 0 or 2000.

9. Attempt to bring pointer on scale by rotating RANGE switch. If pointer remains off scale to the right, push the RANGE EXTENDER "+20" button and set RANGE switch to zero. If off scale to the left, push RANGE EXTENDER "-20" button and set RANGE switch to 20. Zero the meter.

10. Record dial and switch readings, with meter zeroed, i.e.

RANGE EXTENDER	RANGE	DIAL
0	16	1232

FINAL READING:

11. Apply Strain.

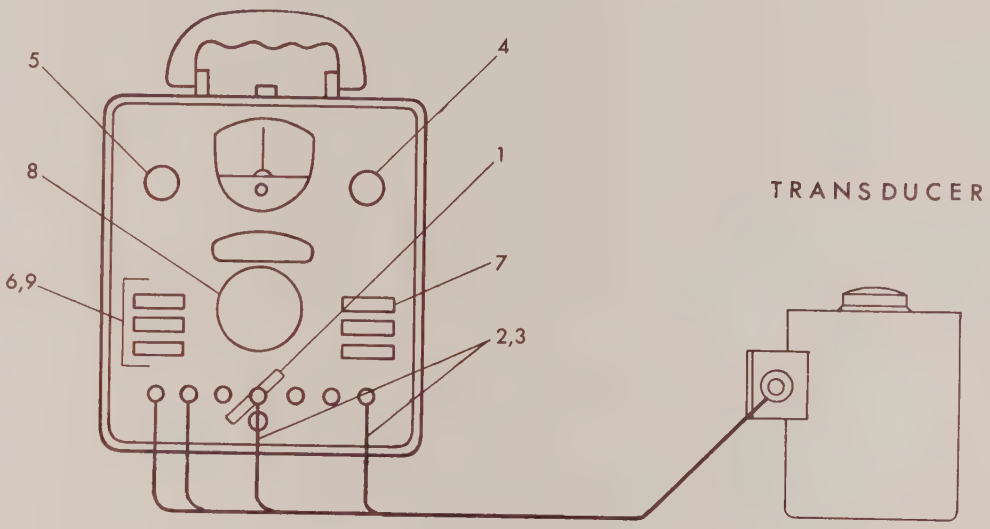
12. Repeat step 9.

13. Record final dial and switch readings with meter zeroed, i.e.

RANGE EXTENDER	RANGE	DIAL
0	20	158

14. Calculate strain according to instructions in Figure 3-14.

Figure 3-10. Operation for External Bridge Circuit (Cont'd)



Preliminary: Make instrument self-check as shown in Figures 3-2/3-3.

INTERCONNECTIONS:

1. Open the jumper connection between terminal R and the two adjacent binding posts.
2. Connect the Black and Green input wires of the transducer cable to the B and G binding posts.
3. Connect the Red and White output transducer lead wires to the R and either of the W binding posts.
4. Set the Gage Factor dial to 2.00.
5. Set RANGE switch to 10.
6. Set RANGE EXTENDER on "0".
7. Push ON button.

Figure 3-11. Operation with Transducer Circuit

STRAIN MEASUREMENT:

Initial Reading: With no load.

8. Rotate balancing knob in a direction to bring meter pointer to zero. If pointer cannot be brought to zero, leave balancing dial at end to which turned and set exactly at 0 or 2000.

9. Attempt to bring pointer on scale by rotating RANGE switch until pointer kicks across scale. If pointer remains off scale to the right, push RANGE EXTENDER "+ 20" button and set RANGE switch to zero. If off scale to the left, push RANGE EXTENDER "-20" button and set RANGE switch to 20. Zero the meter.

10 With meter zeroed, record dial and switch readings, i.e.:

RANGE EXTENDER	RANGE	DIAL
0	16	1232

FINAL READING:

11. Apply load.

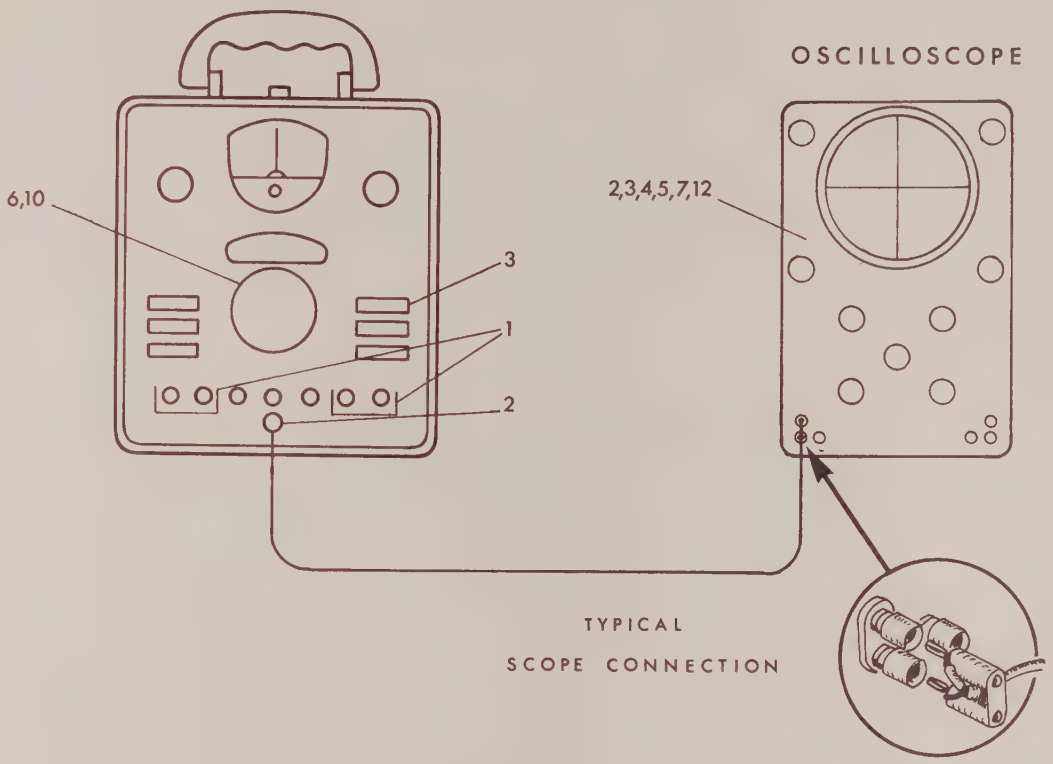
12. Repeat step 9.

13. With meter zeroed, record dial and switch readings, i.e.:

RANGE EXTENDER	RANGE	DIAL
0	16	158

14. Calculate strain by finding the "apparent strain" as shown in Figure 3-14. Divide this figure by 2000. The result will be the true millivolt per volt output of the transducer since 1 mV/V will give a strain indication of 2000 microinches per inch.

Figure 3-11. Operation with Transducer Circuit (Cont'd)



Preliminary: Make instrument self-check as shown in Figures 3-2/3-3.

INTERCONNECTIONS:

1. Connect active and compensating gages to proper terminals on the indicator.

2. Connect SCOPE jack to oscilloscope.

3. Apply power to both the indicator and the oscilloscope.

4. Set oscilloscope vertical sensitivity and horizontal sweep for suitable dc display of dynamic strain.

Figure 3-13. Observation of Dynamic Strain

STRAIN MEASUREMENT.

5. Note the magnitude of the oscilloscope trace with the gages in a static condition.

6. Rotate the main balancing dial with the balancing knob 200 microinches per inch.

7. Observe the change in magnitude of the oscilloscope trace (in divisions).

8. Divide 200 by the total number of divisions of signal change.

9. The result will be equal to the number of microinches per inch for each scale division. Note this figure.

10. Return the balancing dial to the original position, bringing the oscilloscope trace, once again, to minimum.

11. Apply dynamic strain to the gages.

12. Note the change in the oscilloscope trace. The change in magnitude, in divisions, multiplied by the figure as obtained in step 9, above, is equal to the strain on the gages in microinches per inch.

    NOTE: If the dynamic strain on the gages varies from tension to compression, the sign sense may be preserved by rotating the balancing dial enough to prevent the trace from passing through balance.

Figure 3-13. Observation of Dynamic Strain (Cont'd)

STRAIN CALCULATION FORMULA

Strain micro inches per inch

$$= x + (T_2 - T_1)\ 1000 + D_2 - D_1$$

Where x = value from table located inside instrument cover

T_2 = final thousands step number

T_1 = initial thousands step number

D_2 = final dial reading

D_1 = initial dial reading

Figure 3-14. Strain Calculation Formula

SECTION IV
PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. The Model 100P Strain Indicator is a null balance instrument designed to amplify, and convert to a microinch readout, a change in voltage caused by resistance changes in strain gages. Strain gage excitation is accomplished by the oscillator which also provides a reference voltage to the demodulator, and excitation for the measuring circuit. The oscillator and amplifier are powered by the 24 Vdc power supply. The external strain gage bridge is initially balanced with the adjustable internal bridge with no force applied to the gages. When the gages are subjected to strain, the external bridge becomes unbalanced producing a signal which is fed to the differential amplifier and the internal measuring circuit. The demodulator compares this amplified signal with the reference signal from the oscillator and produces a dc signal to the milliammeter. When the milliammeter is manually nulled, the strain on the gages is read on the dial in microinches per inch. Refer to the block diagram, Figure 3-1, and the schematic diagram, Figure 5- 2.

4-3. CIRCUIT ANALYSIS

4-4. Measuring Circuit.

4-5. The measuring circuit consists of two bridges; a measuring bridge, of which the strain gages are a part and an adjustable internal bridge. The two bridges, which are connected in series, are electrically balanced prior to strain application by rotating the slidewire, R47, as shown in the functional diagram, Figure 4-2. As the gages are subjected to strain, the resistance of the external bridge changes, resulting in an unbalanced condition. The voltage unbalance between the bridges at A and A^1 produces a signal which is applied to the input stage of the differential amplifier.

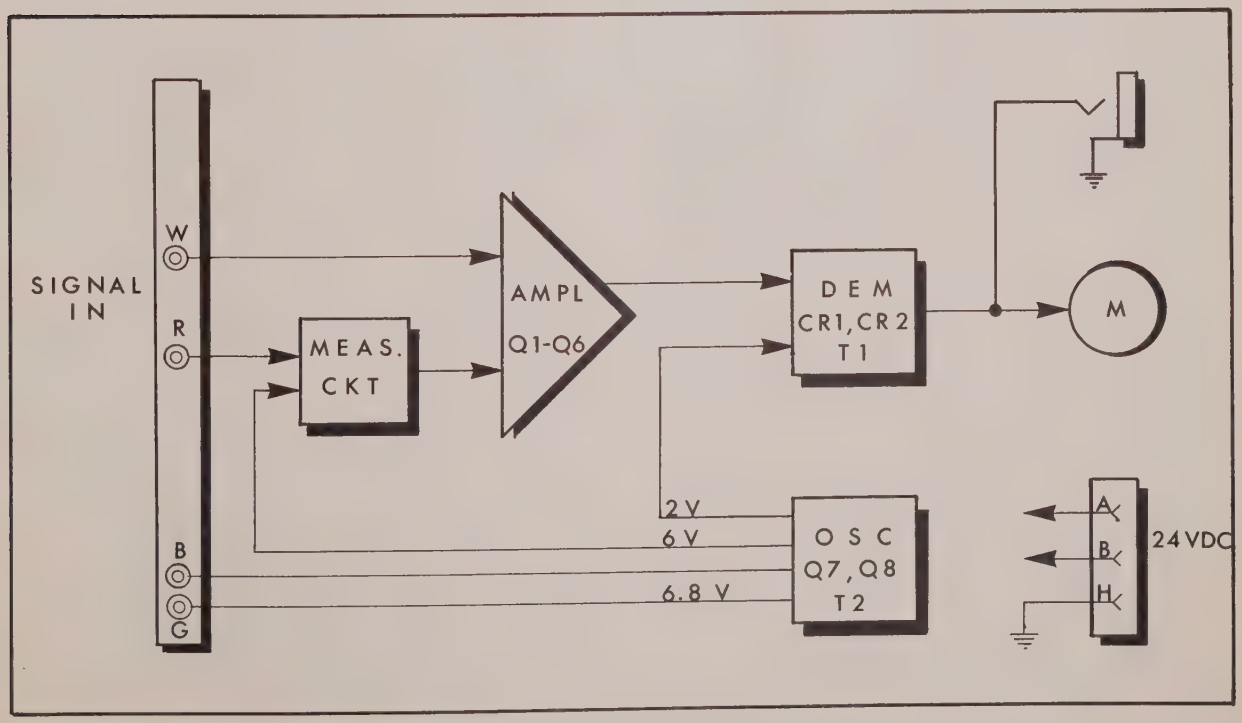


Figure 4-1. 100P Block Diagram

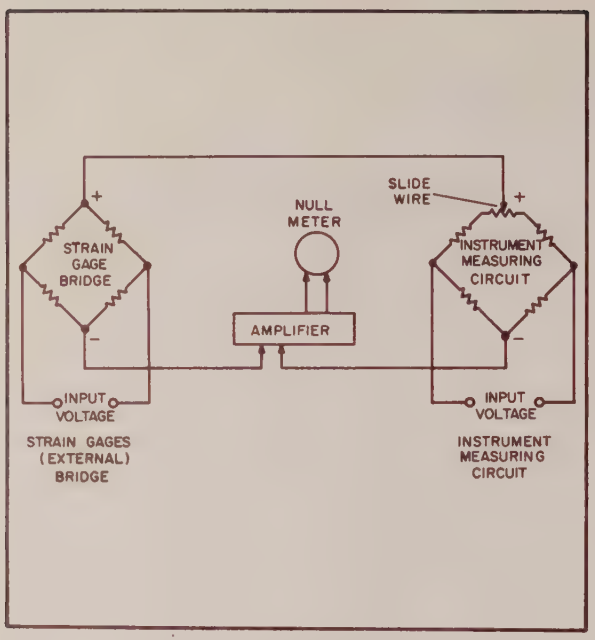


Figure 4-2. Functional Diagram

4-6. Differential Amplifier.

4-7. The signal resulting from the bridge on unbalance of the measuring circuit is applied to the input stage of the differential amplifier at the bases of Q5 and Q6 through pins 4 and 5 of the amplifier board. Q5 and Q6 are capacitively coupled to the next stage of the amplifier at the bases of Q3 and Q4. The signal is again amplified and applied to the bases of Q1 and Q2. Q1 and Q2 operate as a push-pull pair of transistors applying the amplified signal to the demodulator.

4-8. Demodulator.

4-9. The amplified signal from the final stage of the differential amplifier energizes the primary winding of the coupling transformer, T1, at pins 6 and 7. The output of T1 is rectified at the diodes, CR1 and CR2, before being applied to the positive side of the meter, M1, at pin 7 of the amplifier board. Coupling of an oscilloscope at the SCOPE jack, J1, opens the meter circuit at the tip of the jack and transfers the signal to the positive side of the oscilloscope plug, permitting visual observation of dynamic strain.

4-10. Oscillator.

4-11. The oscillator is energized at the primary winding of T2, a saturable core transformer, by the 24 Vdc power supply. The pair of transistors, Q7 and Q8, in conjunction with T2, produce a square wave ac output at a frequency of approximately 2000 Hz. Three separate voltages are obtained at the secondary of T2; approximately they are 5.8 volts, peak to peak, for excitation of the strain gages, approximately 6 volts, peak to peak, for excitation of the internal measuring bridge, and approximately 2 volts, peak to peak, as a reference voltage for the demodulator.

4-12. Power Supply

4-13. The 24 Vdc power supply is provided by two 12.6 volt mercury activator batteries in the Model 100PB and a plug-in transformer/rectifier circuit module in the Model 100PA. The 24 Vdc excitation for the oscillator and amplifier is obtained at pins D & E of the power connector, J2, with pins A and B supplying the line voltage on the Model 100PA. In both instruments, pin H is the ground connection.

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section provides maintenance information for the Model 100P Strain Indicator. Performance checks, troubleshooting and repair information are covered in this section.

5-3. COVER REMOVAL.

5-4. The front cover of the indicator is easily removed by lifting the latch located on the top center of the case. The cover will pivot outward from the top on the two half-hinges located on the bottom of the instrument. Tilt the instrument slightly to the rear and lift the cover from the hinges.

5-5. PERFORMANCE CHECKS.

5-6. Performance checks are designed to check the functioning of the instrument within specified tolerances. Performance checks can be used for incoming quality control inspection, to check performance after repair, or as an aid in troubleshooting.

5-7. Test instruments other than those listed can be used providing the performance equals or exceeds the critical specifications. See Table 5-1 for recommended test equipment.

5-8. ADJUSTMENTS.

5-9. Preliminary.

5-10. Adjustments are made when the Performance Checks indicate such adjustments are necessary or as a result of replacing components. The calibration adjustment as described in figure 3-7 , Section III of this manual,is the only external adjustment and is made when indicated by the calibration check. All other adjustments must be made at the controls mounted on the etched circuit board.

5-11. Internal Adjustments.

5-12. There are three internal adjustments on the Model 100P: meter sensitivity, dynamic strain range, and amplifier balance. Remove instrument from chassis by unfastening the four Phillips-head screws on the front panel assembly. Place the instrument on an insulated surface ; it is not necessary to dismount the etched circuit board from the support brackets. Keep the rear of the etched circuit board clear of the chassis.

5-13. Meter Sensitivity Adjustment.

5-14. Low meter sensitivity is indicated by the failure of the meter pointer to indicate full scale when the balancing dial is rotated 30 to 70 microinches. If the pointer moves offscale before 30 microinches is reached, meter sensitivity is too high.

a. Remove instrument from chassis as described in Paragraph 5-12.

b. Push CHECK button. Meter pointer should deflect past red area.

c. Push ON button and rotate dial 50 microinches.

d. Rotate R-24 in a clockwise direction to increase sensitivity. Rotate counter-clockwise to decrease sensitivity.

e. Adjust meter to read approximately full scale when balancing dial is turned 50 microinches.

5-15. Dynamic Strain Range Adjustment.

5-16. If the performance check indicates the need for a dynamic strain range adjustment, proceed as follows:

a. Remove instrument from chassis as described in Paragraph 5-12.

b. Connect oscilloscope to SCOPE jack on the front panel of the indicator.

c. Connect Model 625 Calibrator, 120 ohm side, to indicator color for color.

d. Set Calibrator Range switch for 0-5mV/V operation.

e. Set Indicator controls as follows:

Power - ON
Gage Factor - 2
Range - 10
Range extender - 0
Shorting Bar - Open

f. Set Calibrator Step switch to 2mV/V.

g. Rotate R25 until oscilloscope indicates 150 mV/V ± 1.6mV/V.

5-17. Amplifier Balance Adjustment.

5-18. Perform this adjustment after replacing any component in the indicator.

a. Remove instrument from chassis as described in paragraph 5-12.

b. Short circuit terminals 4 and 5 of the amplifier board with a jumper wire.

c. Rotate R50 until meter pointer indicates exactly zero.

d. Remove jumper wire from terminals 4 and 5 and replace instrument in chassis.

5-19. TROUBLESHOOTING AND REPAIR

5-20. Preliminary.

5-21. The basic tools for troubleshooting the indicator are the schematics, theory information in Section IV and the checks and adjustments listed in this section. Use the troubleshooting "Tree", Figure 5-3, as an aid in isolating a malfunction to a particular instrument circuit.

5-22. When a malfunction occurs, remove power from the equipment and inspect the unit for broken wires, over-heated or loose components, or similar conditions that could be a source of trouble. Check - that the connectors are not dirty or otherwise contaminated.

5-23. Power Supply Check.

5-24. The Model 100P is operated from a 24Vdc power supply. The Model 100PA comes equipped with a rectifier/filter module located in the power supply compartment. The power supply steps down and rectifies a line voltage of 115Vac to 24Vdc. Check the output of the power supply in the 100P by disconnecting the power cable from the module to the amplifier board and reading the voltage at pins D and E with pins A and B shorted. See Figure 5-1 for a schematic diagram of the Model 100PA power supply circuit.

5-25. The Model 100PB comes equipped with two 12.6 V mercury activator batteries located in the power supply compartment at the rear of the instrument. Check the voltage output by disconnecting the power cable from the battery box to the amplifier board and reading the voltage output at pins D & E with pins A & B shorted.

5-26. Replacing Batteries.

5-27. Unfasten the power supply access plate in the rear of the instrument, remove the battery box from the compartment and disconnect the power cable. Lift the cover from the battery box, disconnect the battery leads, and replace with two 12.6V mallory type TR 289 batteries or equivalent. It is recommended one battery be replaced before installing the other to avoid the possibility of reversing battery polarity.

5-28. Slidewire Cleaning and Lubrication.

5-29. Continued use of the indicator in extremely dusty locations may cause an accumulation of dirt to form on the balancing slidewire or slidewire contact arm. This condition will become apparent through a jittery or jumpy balance indicator pointer or the indicator may develop a small zero shift.

5-30. To clean the slide wire, remove the front panel assembly as described in paragraph 5-12. Rub contact surface briskly and lightly with a clean cloth using new portions of the wiper until the cloth stays clean. Do not use a cloth that will leave lint or fibers on the wire. If the slide wire is gummy and cannot be cleaned with a dry cloth, brush the contact surface with a good commercial grade of benzine applied with a camel hair brush, and dry with a clean cloth. If the slide wire surface is so dirty that the above procedure does not clean it, return the entire instrument to BLH. After the slidewire has been cleaned, the contact surface may be lubricated with a very thin film of high-grade oil or white vaseline. Apply the oil or vaseline with the end of a finger and keep the film as thin as possible. The slidewire contact tension should not be more than 2 ounces.

CAUTION

Do not remove the slidewire from the instrument unless absolutely necessary, or use any cleaner that will attack the glyptal varnish used to attach the slidewire to the drum. Use of an abrasive on the contact surface, or snapping the contact on and off the slidewire will induce calibration errors.

5-31. Transistor Replacement.

Transistors are inherently long-lived devices and should be replaced only when indicated as faulty. Do not check soldered-in transistors by substitution as the transistor or circuit board may be damaged. Leakage current from the soldering iron or a momentary short can permanently damage a transistor.

5-32. Refer to paragraph 5-33 before attempting to replace a transistor, then use a hot 50 watt or smaller iron. Apply heat to the leads of part to be replaced, NOT to the printed circuit on the board. Clean holes before installing the new transistor. Use long-nose pliers as a heat sink between the iron and transistor. Allow the transistor to cool before applying power to the unit.

5-33. Servicing Etched Circuit Boards.

Excessive heat or pressure can lift the copper strip from the board. Avoid damage by using a low-power soldering iron (50 watts maximum) and following these instructions. Copper that lifts off the board should be cemented in place with a quick-drying acetate base cement having good electrical insulating properties. A break in the copper should be repaired by soldering a short length of tinned copper wire across the break. Use only high quality rosin core solder when repairing etched circuit boards. NEVER USE PASTE FLUX. After soldering, clean off any excess flux and coat the repaired area with a high quality electrical varnish or lacquer. When replacing components with multiple mounting pins such as transistors, electrolytic capacitors, and potentiometers, it will be necessary to lift each pin slightly, working around the component several times until it is free.

a. Apply heat sparingly to lead of component to be removed. If lead passes through an eyelet in the circuit board, apply heat on the component side. If lead does not pass through an eyelet, apply heat on the conductor side of the board.

b. Reheat solder in vacant eyelet and quickly insert a wood sliver or toothpick to clean inside of hole.

c. Bend clean tinned leads on new component and carefully insert through eyelets or holes on board.

d. Hold part against board (avoid overheating) and solder leads. Apply heat to component leads on correct side of board as explained in step 'a' above.

e. If the steps above are impractical or if the board has been damaged, clip the leads of the component to be removed close to the part itself leaving as long leads as possible still soldered to the board.

f. Straighten old leads and bend leads of new part around the protruding leads. Apply solder using a pair of long-nose pliers for a heat sink.

Table 5-1. Recommended Test Equipment

TYPE	CHARACTERISTICS	PURPOSE	RECOMMENDED
Calibrator	Output accuracy at each point 0.1% or ± 0.0003 mV/V which ever is greater.	Performance check and troubleshooting	BLH Model 625 Precision Calibrator
AC/DC VTVM	1 mV to 100 V, 10 megohm impedance	Performance check and troubleshooting	
Decade Resistor	Total resistance, 10,000 ohms, multiple of 1 ohm . .05% accuracy	Performance check and troubleshooting	
Multimeter	±1% accuracy at full scale input impedance 200 megohms.	Troubleshooting	
Oscilloscope	200 kHz bandwidth	Troubleshooting	
Signal Generator	Continuously variable 0 to 1200 Hz, sine wave, 500 mV output	Troubleshooting	

Table 5-2. Performance Checks

RANGE SWITCH CHECK:

Perform the instrument self-check as described in Figure 3-2, Section III of this manual, before attempting this check.

a. Open the jumper connection between binding post R and the two adjacent terminals.

b. Connect the terminals on the 120Ω side of a BLH Model 625 calibrator to the indicator, color for color, as shown below. Connect the white lead to either of the W terminals.

c. Set the Calibrator controls as follows:

Bridge selector switch	- 120Ω
Range switch	- 0-5
Step switch	- 0

d. Set the Indicator controls as follows:

GAGE FACTOR	- 2.00
RANGE	- 10
Power	- ON

e. Balance Indicator with balancing knob and note reading.

f. Set Calibrator to 1mV/V with step switch.

g. Set Indicator RANGE switch to 8 and re-balance indicator with balancing knob. Note reading. Dial reading should be same as initial reading ± 2.5 microinches per inch.

h. Continue sequence, rotating indicator RANGE switch clockwise until 0 on the Indicator and 5mV/V on the Calibrator is reached.

i. Reverse black and green leads at the Calibrator.

j. Reset Calibrator step switch to 0.

k. Reset Indicator RANGE switch to 10 and re-balance indicator. Note reading.

l. Set Calibrator step switch to 1mV/V and turn indicator RANGE switch to 12. Dial reading should be same as initial reading ± 2.5 microinches.

m. Continue sequence until 20 on the indicator and 5mV/V on the calibrator is reached. Dial reading, in each case, should be within 2.5 microinches of reading in previous step.

METER SENSITIVITY CHECK:

Perform the instrument self-check as described in Figure 3-2, Section III of this manual, before attempting this check.

a. Open the jumper connection between binding post R and the two adjacent terminals.

b. Connect the terminals on the 120Ω side of a BLH Model 625 Calibrator to the Indicator, color for color, as shown below. Connect the white lead to either of the W terminals.

c. Set the Calibrator controls as follows:

Bridge selector switch	- 120Ω
Range switch	- 0.5
Step switch	- 0

d. Set the Indicator controls as follows:

GAGE FACTOR	- 2.00
RANGE	- 10
Power	- ON

e. Balance Indicator with balancing knob and note reading.

f. Rotate balancing knob until meter pointer indicates full scale at either end of the meter. Note final dial reading.

g. Find the difference between the initial and final readings. The meter should indicate full scale between 30 and 70 micro inches per inch.

DIAL CHECK:

Perform the instrument self-check as described in Figure 3-2, Section III of this manual, before attempting this check.

a. Open the jumper connection between binding post R and the two adjacent terminals.

b. Connect the terminals on the 120Ω side of a BLH Model 625 Calibrator to the Indicator, color for color, as shown below. Connect the white lead to either of the W terminals.

c. Set Calibrator controls as follows:

Bridge selector switch	- 120Ω
Range switch	- 0-.5
Step switch	- 0

d. Set Indicator controls as follows:

GAGE FACTOR	- 2.00
RANGE	- 10
Power	- ON

e. Balance the Indicator with the balancing knob. Note reading.

f. Set Calibrator step switch to .05.

g. Re-balance Indicator. Note reading. Difference between the initial and final readings should be 100 microinches ±3 microinches per inch.

h. Set Calibrator step switch to .1.

i. Subtract new reading from final reading obtained in step g. above. Difference should be 100 microinches ±3 microinches per inch.

j. Continue sequence until reading at .5 mV/V is obtained.

k. Reverse black and green leads at the Calibrator and repeat steps c through j above.

DYNAMIC STRAIN RANGE CHECK:

Perform the instrument self-check as described in Figure 3-2, Section III of this manual, before attempting this check.

a. Open the jumper connection between binding post R and the two adjacent terminals.

b. Connect the terminals on the 120Ω side of a BLH Model 625 Calibrator to the Indicator, color for color, as shown below. Connect the white lead to either of the W terminals.

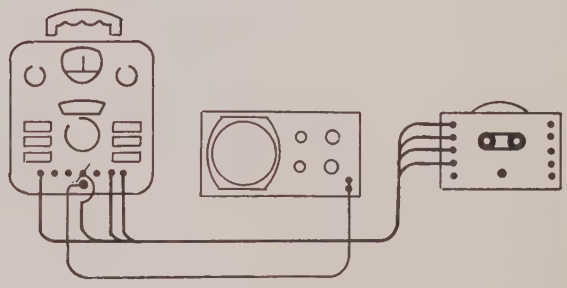
c. Set the Calibrator controls as follows:

Bridge selector switch	- 120Ω
Range switch	- 0.5
Step switch	- 0

d. Set the Indicator controls as follows:

GAGE FACTOR	- 2.00
RANGE	- 10
Power	- ON

e. Balance indicator with balancing knob and note reading.



f. Connect oscilloscope to SCOPE jack on front panel of the instrument.

g. With the Calibrator, apply the equivalent of 4000 microinches per inches of strain (2.00 mV/V).

h. Oscilloscope should indicate 150 mV dc ± ± 1.5 mV/V.

Table 5-3. Schematic Diagram Notes

REFER TO (MIL-STD-15-1) FOR SCHEMATIC SYMBOLS NOT LISTED IN THIS TABLE

= ETCHED CIRCUIT BOARD

= FRONT PANEL MARKING

= REAR PANEL OR INTERNAL ADJUSTMENT MARKING

= FRONT PANEL CONTROL

= SCREWDRIVER ADJUSTMENT

CW = INDICATES MOVABLE CONTACT POSITION AT CLOCKWISE ROTATION LIMIT OF CONTROL SHAFT. (SHAFT VIEWED FROM KNOB OR SLOTTED END)

= PRIMARY SIGNAL PATH

= FEEDBACK PATH

= WAVEFORM TEST POINT (WITH NUMBER)

= COMMON POINT (WITH LETTER)

= AVALANCHE (ZENER) DIODE

= TUNNEL DIODE

= STEP RECOVERY DIODE

= SIGNAL GROUND

= CHASSIS

N.C. = NO CONNECTION P/O = PART OF

* = OPTIMUM VALUE SELECTED AT FACTORY, AVERAGE VALUE SHOWN; PART MAY HAVE BEEN OMITTED.

UNLESS OTHERWISE INDICATED:
CAPACITANCE IN PICOFARADS
INDUCTANCE IN MICROHENRIES
RESISTANCE IN OHMS

NUMBERS IN PARENTHESES INDICATE WIRE COLOR USING RESISTOR COLOR CODE
e.g. WHT-RED-GRN is (9-2-5)

0 – BLACK	5 – GREEN
1 – BROWN	6 – BLUE
2 – RED	7 – VIOLET
3 – ORANGE	8 – GRAY
4 – YELLOW	9 – WHITE

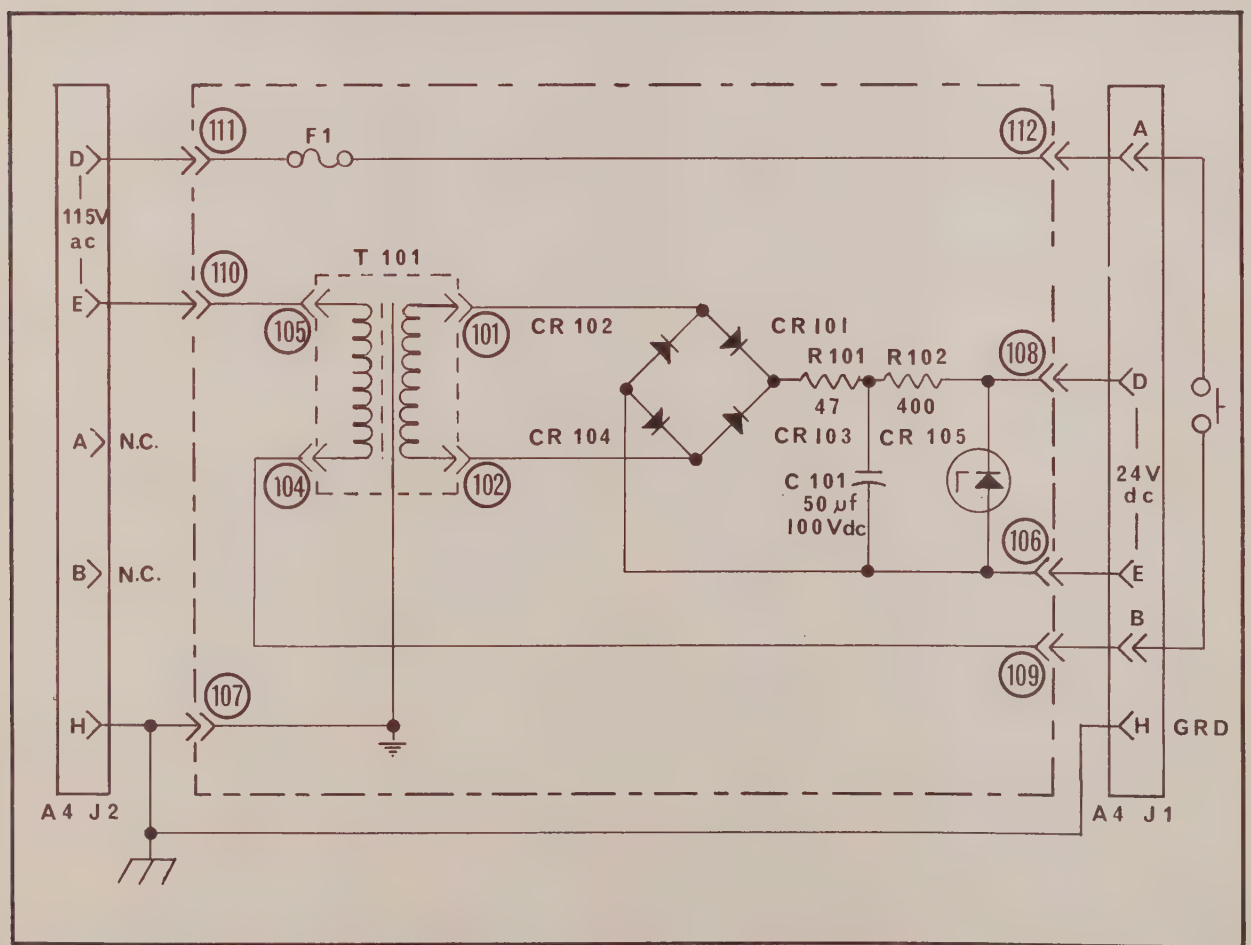
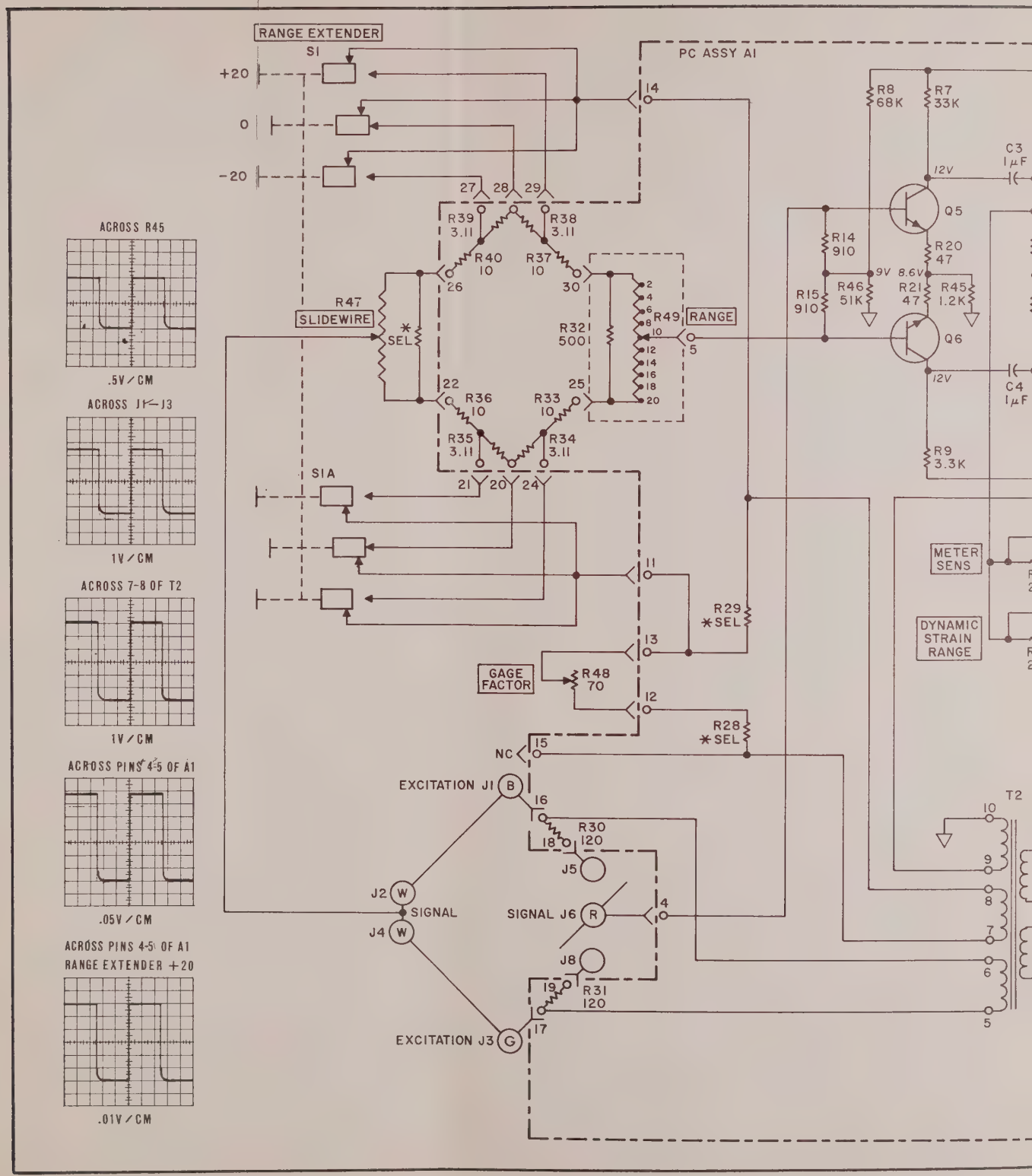


Figure 5-1. Schematic Diagram Model 100PA Power Supply


RANGE EXTENDER
S1
+20
0
-20
PC ASSY A1
R8 68K
R7 33K
C3 1μF
12V
Q5
R14 910
R20 47
9V
8.6V
R15 910
R46 51K
R21 47
R45 1.2K
Q6
C4 1μF
R9 3.3K
R39 3.11
R38 3.11
R40 10
R37 10
R47 SLIDEWIRE
SEL
R32 500
R49
RANGE
R36 10
R33 10
R35 3.11
R34 3.11
S1A
METER SENS
DYNAMIC STRAIN RANGE
R29 SEL
GAGE FACTOR
R48 70
R28 SEL
NC
EXCITATION J1
R30 120
J5
J2
SIGNAL
J4
SIGNAL J6
J8
R31 120
EXCITATION J3
T2
ACROSS R45
.5V/CM
ACROSS J1-J3
1V/CM
ACROSS 7-8 OF T2
1V/CM
ACROSS PINS 4-5 OF A1
.05V/CM
ACROSS PINS 4-5 OF A1
RANGE EXTENDER +20
.01V/CM

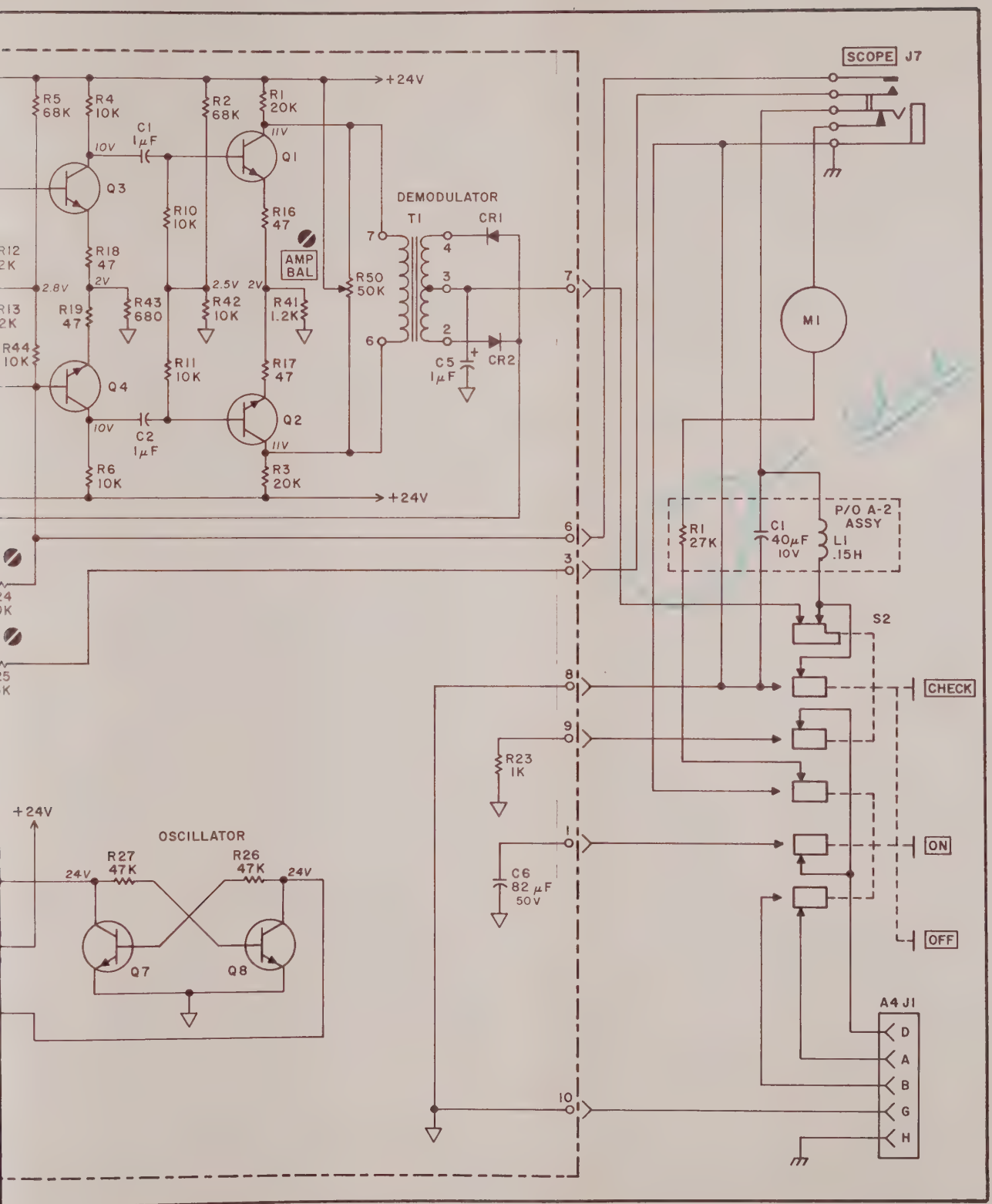
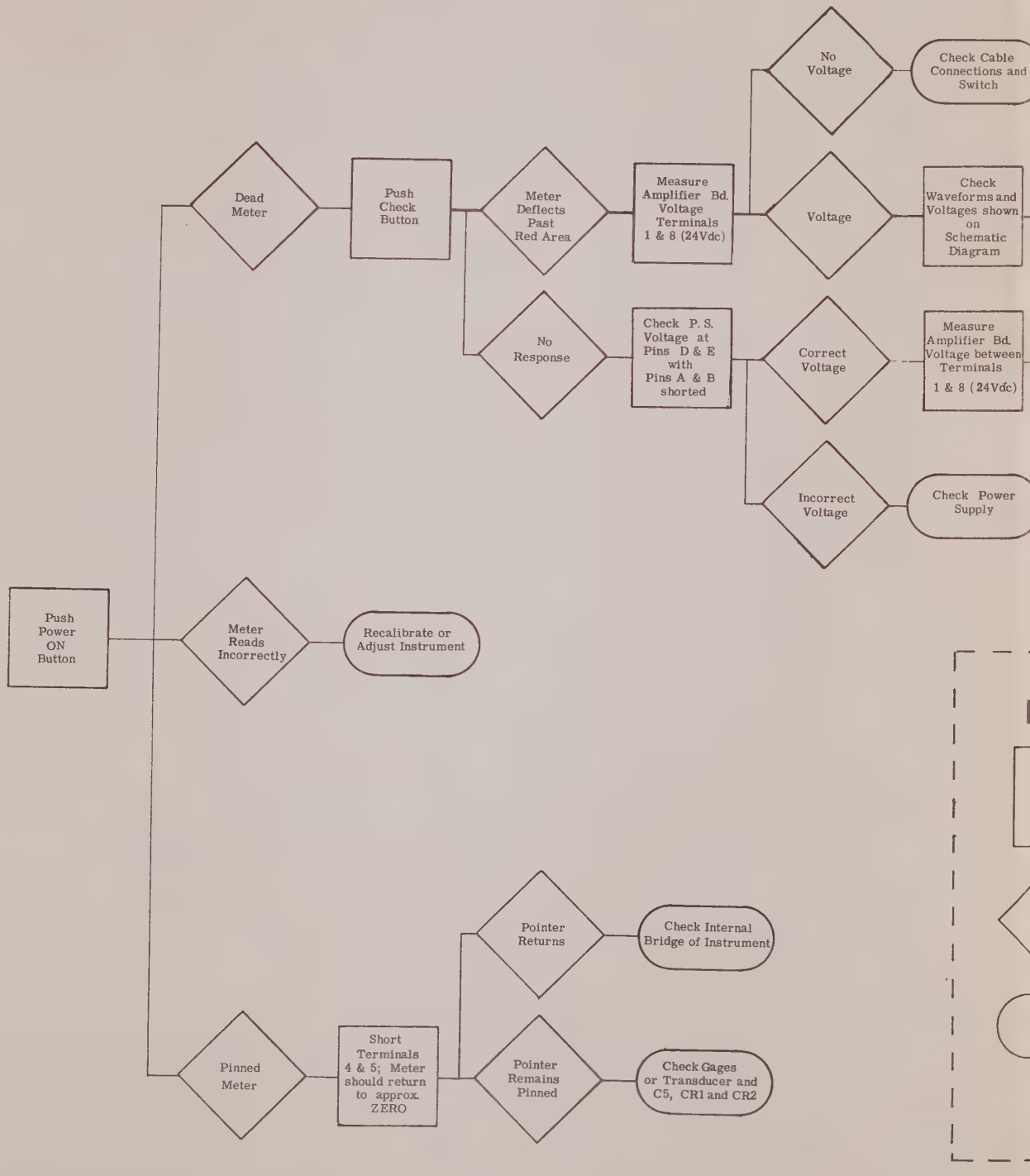
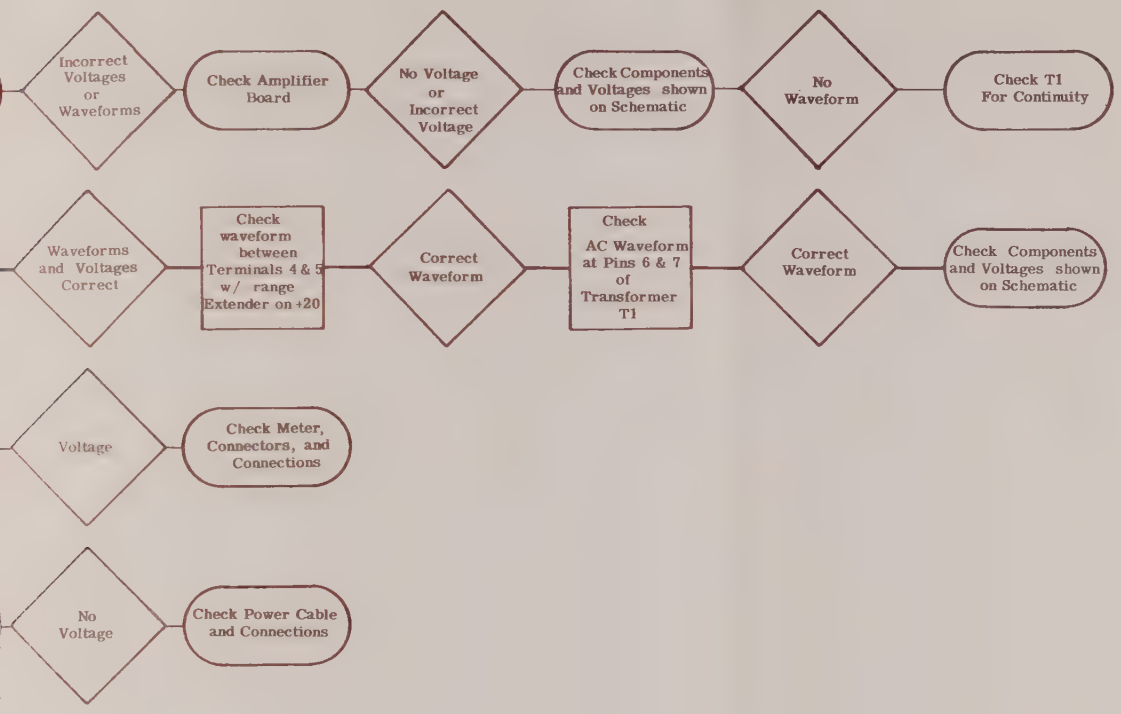


Figure 5-2. Schematic Diagram


Push Power ON Button
Dead Meter
Push Check Button
Meter Deflects Past Red Area
Measure Amplifier Bd. Voltage Terminals 1 & 8 (24Vdc)
No Voltage
Check Cable Connections and Switch
Voltage
Check Waveforms and Voltages shown on Schematic Diagram
No Response
Check P. S. Voltage at Pins D & E with Pins A & B shorted
Correct Voltage
Measure Amplifier Bd. Voltage between Terminals 1 & 8 (24Vdc)
Incorrect Voltage
Check Power Supply
Meter Reads Incorrectly
Recalibrate or Adjust Instrument
Pinned Meter
Short Terminals 4 & 5; Meter should return to approx. ZERO
Pointer Returns
Check Internal Bridge of Instrument
Pointer Remains Pinned
Check Gages or Transducer and C5, CR1 and CR2


Incorrect Voltages or Waveforms
Check Amplifier Board
No Voltage or Incorrect Voltage
Check Components and Voltages shown on Schematic
No Waveform
Check T1 For Continuity
Waveforms and Voltages Correct
Check waveform between Terminals 4 & 5 w/ range Extender on +20
Correct Waveform
Check AC Waveform at Pins 6 & 7 of Transformer T1
Correct Waveform
Check Components and Voltages shown on Schematic
Voltage
Check Meter, Connectors, and Connections
No Voltage
Check Power Cable and Connections

OGIC

PROCEDURE

RESULT

CORRECTION

INITIAL CONDITIONS

A. BALANCE INTERNAL BRIDGE BY CONNECTING A 120 OHM PRECISION RESISTOR BETWEEN THE MEASURING GAGE TERMINALS, AND A SIMILAR (MATCHED), 120 OHM RESISTOR BETWEEN THE COMPENSATING GAGE TERMINALS.

B. SET CONTROLS FOR BALANCE:

1. BALANCING DIAL - 1000
2. RANGE EXTENDER - 0
3. RANGE - 10
4. GAGE FACTOR - 2
5. SHORTING BAR ASSEMBLY - SHORTED

C. WITH CONDITIONS A AND B ESTABLISHED, THE METER SHOULD REMAIN AT ZERO WHEN POWER IS TURNED ON. ROTATION OF THE BALANCING DIAL TO 950-930 OP. 1050-1070 MICROINCHES PER INCH SHOULD DEFLECT THE METER FULL SCALE TO THE RIGHT OR LEFT RESPECTIVELY.

D. IF THESE CONDITIONS CANNOT BE OBTAINED, START TROUBLESHOOTING PROCEDURE.

Figure 5-3. Troubleshooting Tree

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for identifying and ordering replacement parts. Table 6-1 lists in alpha-numeric order by reference designator and provides the following information on each part:

a. BLH part number (where BLH is sole source).

b. Total quantity used in the instrument (TQ column). Quantity listed where item first appears on list.

c. Recommended spares for year application in a remote location (or 2000 hours). RS column.

d. Typical manufacturer of the part (where applicable) in a five-digit code taken from the Federal Supply Code for Manufacturers, Handbooks H4-1 (Name to Code) and H4-2 (Code to Name).

e. Manufacturer's part number.

6-3. ORDERING INFORMATION.

6-4. To obtain replacement parts, address order or inquiry for parts to the nearest BLH Sales/Service Office (see lists at the rear of this manual) or direct to BLH. Identify parts by BLH part numbers.

6-5. To order parts not listed in Table 6-1 provide the following:

a. Model number of instrument.

b. Serial number of the unit.

c. Description of the part including function and location.

6-6. To order a part from a manufacturer other than BLH, provide the component part description and the Manufacturers code and part number from Table 6-1.

DESIGNATORS

A	= assembly	F	= fuse	P	= plug	TC	= thermocouple
B	= motor	FL	= filter	Q	= transistor	V	= vacuum tube, neon bulb, photocell etc.
BT	= battery	HR	= heater	QCR	= transistor-diode	W	= cable
C	= capacitor	J	= jack	R	= resistor	X	= socket
CR	= diode	K	= relay	RT	= thermistor	XDS	= lampholder
DL	= delay line	L	= inductor	S	= switch	XF	= fuseholder
DS	= lamp	M	= meter	T	= transformer	Z	= network
E	= misc electronic part	MP	= mechanical part	TB	= terminal board		

ABBREVIATIONS

A	= ampere (s)	H	= henry (ies)	nA	= nanoampere (s) = 10^{-9}	Se	= selenium
Ag	= silver	Hg	= mercury	NC	= normally closed	sect	= section (s)
Al	= aluminum	Hz	= cycles per second	Ne	= neon	Si	= silicon
Au	= gold			NO	= normally open	si	= slide
		ID	= inside diameter	NPO	= negative positive zero (zero temperature coefficient)	SPDT	= single-pole double-throw
C	= capacitor	impg	= impregnated			SPST	= single-pole single-throw
cer	= ceramic	incd	= incandescent	ns	= nanosecond (s) = 10^{-9}		
coef	= coefficient	ins	= insulation (ed)			Ta	= tantalum
com	= common			Ω	= ohm (s)	tog	= toggle
comp	= composition	KΩ	= kilohm (s) = 10^{+3}	OD	= outside diameter	tol	= tolerance
conn	= connection	kg	= kilogram			trim	= trimmer
		KHz	= kilocycle (s) = 10^{+3}	p	= peak	TSTR	= transistor
dep	= deposited			pc	= printed circuit		
DPDT	= double-pole double-throw	L	= indicator	pF	= picofarad (s) = 10^{-12}	V	= volt (s)
		lin	= linear taper	piv	= peak inverse voltage	vacw	= alternating current working volt (s)
DPST	= double-pole single-throw	log	= logarithmetic taper	p/o	= part of	var	= variable
				pos	= position (s)	vdcw	= direct current working volt (s)
		m	= milli = 10^{-3}	poly	= polystyrene		
elect	= electrolytic	mA	= milliampere (s) = 10^{-3}	pot	= potentiometer	W	= watt (s)
encap	= encapsulated	mH	= millihenry (s) = 10^{-3}	p-p	= peak-to-peak	w/	= with
		MHz	= megacycle (s) = 10^{+6}	prec	= precision (temperature coefficient, long term stability, and/or tolerance.)	w/o	= without
F	= farad (s)	MΩ	= megohm (s) = 10^{+6}			ww	= wirewound
FET	= field effect transistor	met flm	= metal film				
fxd	= fixed	mfr	= manufacturer			*	= optimum value selected at factory, average value shown (part may be omitted)
		mtg	= mounting				
GaAs	= gallium arsenide	μ	= micro = 10^{-6}	R	= resistor		
GHz	= gigacycle (s) = 10^{+9}	my	= Mylar®	rms	= root-mean-square		
gd	= guard			rot	= rotary		
Ge	= germanium						
grd	= ground (ed)						

® Dupont de Nemours

Table 6-1. Replaceable Parts

Ref Desig	Part No.	RS	TQ	Description	Mfr	Mfr Part No.
End Item				100P Portable Strain Indicator Fig. 6-1.		
A1	W970AB	-	1	Assy: Amplifier, Figure 6-2.		
A2	W970AW	-	1	Assy: Front Panel, Figure 6-3/6-4.		
A3	E104WX	-	1	Assy: Case		
A4	W970BA	-	1	Assy: Power Supply 100PA, Figure 6-5.		
A5	W970ZA	-	1	Assy: Power Supply 100PB		
A1	W970AB	-	1	Assy: Amplifier, Figure 6-2.		
	W970AF	-	1	Board: PC, Amplifier		
A1C1	N131NX	5	5	C: Fxd. mylar 1μF 25V		
C2	-	-	-	C: same as C1		
C3	-	-	-	C: same as C1		
C4	-	-	-	C: same as C1		
C5	-	-	-	C: same as C1		
C6	-	1	1	C: Elect. 82μF 50V		
A1CR1	N109EZ	1	2	Scon: Device, diode		
CR2	-	1	-	same as CR1		
A1Q1	N131BP	6	6	Transistor: Si NPN 2N1711		
Q2	-	-	-	same as Q1		
Q3	-	-	-	same as Q1		
Q4	-	-	-	same as Q1		
Q5	-	-	-	same as Q1		
Q6	-	-	-	same as Q1		
Q7	N119KT	2	2	Transistor: Si NPN 2N657		
Q8	-	-	-	same as Q7		
A1R1	E110CL	-	2	R: Comp. 20K 5% 1/2W		
R2	N109FM	-	3	R: Comp. 68K 5% 1/2W		
R3	-	-	-	same as R1		
R4	E10ZCS	-	6	R: Comp. 10K 5% 1/2W		
R5	-	-	-	same as R2		
R6	-	-	-	same as R4		
R7	E122BS	-	2	R: Comp. 3.3K 5% 1/2W		
R8	-	-	-	same as R2		
R9	-	-	-	same as R7		
R10	-	-	-	same as R4		
R11	-	-	-	same as R4		
R12	49612	-	2	R: Comp. 2K 5% 1/2W		
R13	-	-	-	same as R12		
R14	K109BB	-	2	R: Comp. 910Ω 5% 1/2W		
R15	-	-	-	same as R14		

Table 6-1. Replaceable Parts (cont.)

Ref Desig	Part No.	RS	TQ	Description	Mfr	Mfr Part No.
R16	N110BV	-	6	R: Comp. 47 Ω 5% 1/2W		
R17	-	-	-	same as R16		
R18	-	-	-	same as R16		
R19	-	-	-	same as R16		
R20	-	-	-	same as R16		
R21	-	-	-	same as R16		
R22	-	-	-	not assigned		
R23	49597	-	1	R: Comp. 1K 5% 1/2W		
R24	N120AR	1	1	R: variable, 20K		
R25	N131FB	1	1	R: variable, 500 Ω		
R26	E122CX	-	2	R: Comp. 47K 1/2W		
R27	-	-	-	same as R26		
R28	*	-	2	optimum value selected at factory average value is 270 Ω		
R29	*	-	-	same as R28		
R30	E104RN	-	2	R: WW120 Ω .01%		
R31	-	-	-	same as R30		
R32*	E102EC	-	1	R: WW 500Ω .01%		
R33	W970AL	-	-	R: WW 10 Ω .01%		
R34		-	-	R: WW 3.11Ω .01%		
R35		-	-	R: WW 3.11Ω .01%		
R36		-	-	R: WW 10Ω .01%		
R37	-	-	-	same as R33, R34, R35, R36		
R38		-	-			
R39		-	-			
R40		-	-			
R41	E122AT	-	2	R: Comp. 1.2K 5% 1/2W		
R42	-	-	-	same as R41		
R43	J103MA	-	1	R: Comp. 680Ω 5% 1/2W		
R44	-	-	-	same as R4		
R45	-	-	-	same as R41		
R46	E122FA	-	1	R: Comp. 51K 5% 1/2W		
R50	N128WM	1	1	R: variable 50K		
A1T1	E104RX	-	1	Transformer		
T2	W970AK	-	1	Transformer: saturable		
A2	W970AW	-	1	Assy: Front Panel, Figure 6-2/6-3.		
A2C1	N109BM	-	1	C: Elect. 40μF, 10V		
J1	E104NT	3	6	Assy: Jack, MEASURING GAGE		
J2	-	-	-	same as J1		
J3	E104NT	-	-	Assy: Jack, COMPENSATING GAGE		
J4	-	-	-	same as J3		
J5	-	-	-	same as J3		

Table 6-1. Replaceable Parts (cont.)

Ref Desig	Part No.	RS	TQ	Description	Mfr	Mfr Part No.
J6	E104YE	1	1	Assy, Binding Post w/Shorting bar		
J7	E104PA	-	1	Assy: Jack, SCOPE		
J8	E104NT	-	-	Same as J3		
L1	N1Z0AP	-	1	Inductor, .15H		
M1	E104NX	-	1	Meter: 0-1-0 mA		
A2MP1	E104WT	-	1	Panel: Aluminum		
MP2	E104NY	-	1	Window: dial		
MP3	35871	-	1	Assy: Brush		
MP4	E104N2	-	1	Bearing		
MP5	E104PB	-	1	Plate		
MP6	E104PT	-	1	Pushbutton: CHECK		
MP7	E104PS	-	1	Pushbutton: OFF		
MP8	E104PR	-	1	Pushbutton: ON		
MP9	E104PW	-	1	Knob: GAGEFACTOR		
MP10	E104PY	-	1	Knob: RANGE		
MP11	E104PZ	-	1	Knob: Dial		
MP12	E104PP	-	1	Pushbutton: +20		
MP13	E104PN	-	1	Pushbutton: 0		
MP14	E104PM	-	1	Pushbutton: -20		
MP15	E104RA	-	1	Assy: Pointer Gage Factor		
MP16	44220	-	1	Stop: Dial		
MP17	E104TR	-	1	Gasket: Dial window		
MP18	E104TX	-	1	Mechanism: Dial		
MP19	E104XN	-	2	Column		
MP20	-	-	-	same as MP19		
MP21	E104PK	-	1	Bracket: RH		
MP22	E104PE	-	1	Bracket: LH		
MP23	E113BT	-	1	Bracket: Inductor		
A2R1	J106AX	-	1	R: Comp. 27K ±10% 1/2W		
R2	E104AC	1	1	Assy: Slidewire		
R3	E104BR	1	1	R: variable, Gage Factor 70Ω		
R4	E104AH	-	1	R: Stepswitch, Range		
A2S1	E104NR	-	1	Switch: Check, Power		
S2	E104NP	-	1	Switch: Range Extender		
S3	E104TY	-	1	Switch: Momentary P.B., OFF.		
A3	E104WX	-	1	Assy: Case		
A3MP1	E129EB	-	1	Bumper: Rubber		
MP2	6546	-	1	Screw: 5-40 x 1		
MP3	X104BS	-	1	Nut: 5-40		
MP4	E104XE	-	1	Panel: Rear Cover		

Table 6-1. Replaceable Parts (cont.)

Ref Desig	Part No.	RS	TQ	Description	Mfr	Mfr Part No.
A4	W970BA	-	-	Assy: 100PA Power Supply, Figure 6-5.		
	W970BC	-	-	Assy: Board, PC		
A4C101	N122LK	1	1	C: Electrolytic, 50μF		
CR101	N109E2	2	4	Scon Device: diode 1N645		
CR102	-	-	-	same as CR101		
CR103	-	-	-	same as CR101		
CR104	-	-	-	same as CR101		
CR105	W970BK	1	1	Scon Device: Zener diode 24V 5%		
A4F1	K100EA	10	1	Fuse: 1/16 amp.		
A4J1	N121LL	-	1	Connector: Female, 5 pin		
J2	W970ZY	-	1	Connector: Male, 5 pin		
A4MP1	W970BC	-	1	Bracket: Case		
MP2	W970BF	-	1	Cover: Case		
MP3	W970BR	-	1	Socket: 3 prong w/hardware		
MP4	E104XK	-	1	Insulator		
A4R101	E122RX	-	1	R: Comp. 47Ω 5% 1/2W		
R102	L103BB	-	1	R: Comp. 400Ω 5% 1/2W		
T101	W970BB	-	1	Transformer: power		
A5	W970ZA	-	1	Assy: Power Supply (Model 100P.B.)		
A5B1	W970BL	-	2	Battery: Mercury Activator		
B2	-	-	-	same as B1		
A5J1	W970ZY	-	1	Connector: Female, 5 pin		
A5MP1	W970CC	-	2	Clip: Battery		
MP2	-	-	-	same as MP1		
MP3	W970ZB	-	1	Box: Battery		
				MISCELLANEOUS		
	W970BW	-	1	Assy: Cable w/connector for use with 100PA and converted Model 100PB		
	W970BY	-	1	Cord: Power, for use with 100PA and for converted Model 100PB		
	E104TT	-	2	Pad: Foam rubber		
	E104SS	-	1	Instruction Form (located on inst. cover; supply serial number when reordering)		
	E104TW	-	1	Label (located on bottom of inst. case; supply inst. serial number when reordering)		
	W970CK	-	1	Assy cable: Battery hookup		

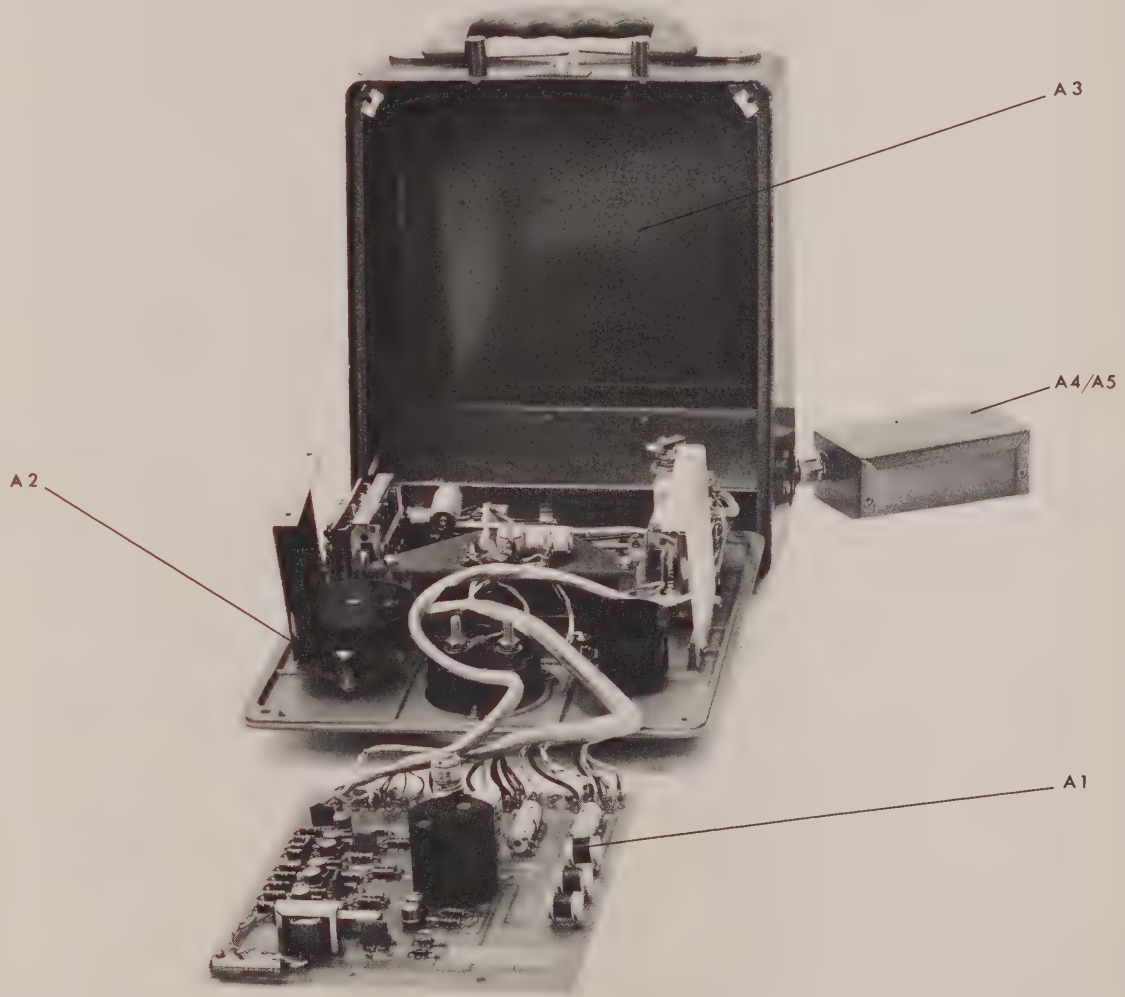


Figure 6-1. Model 100P Strain Indicator

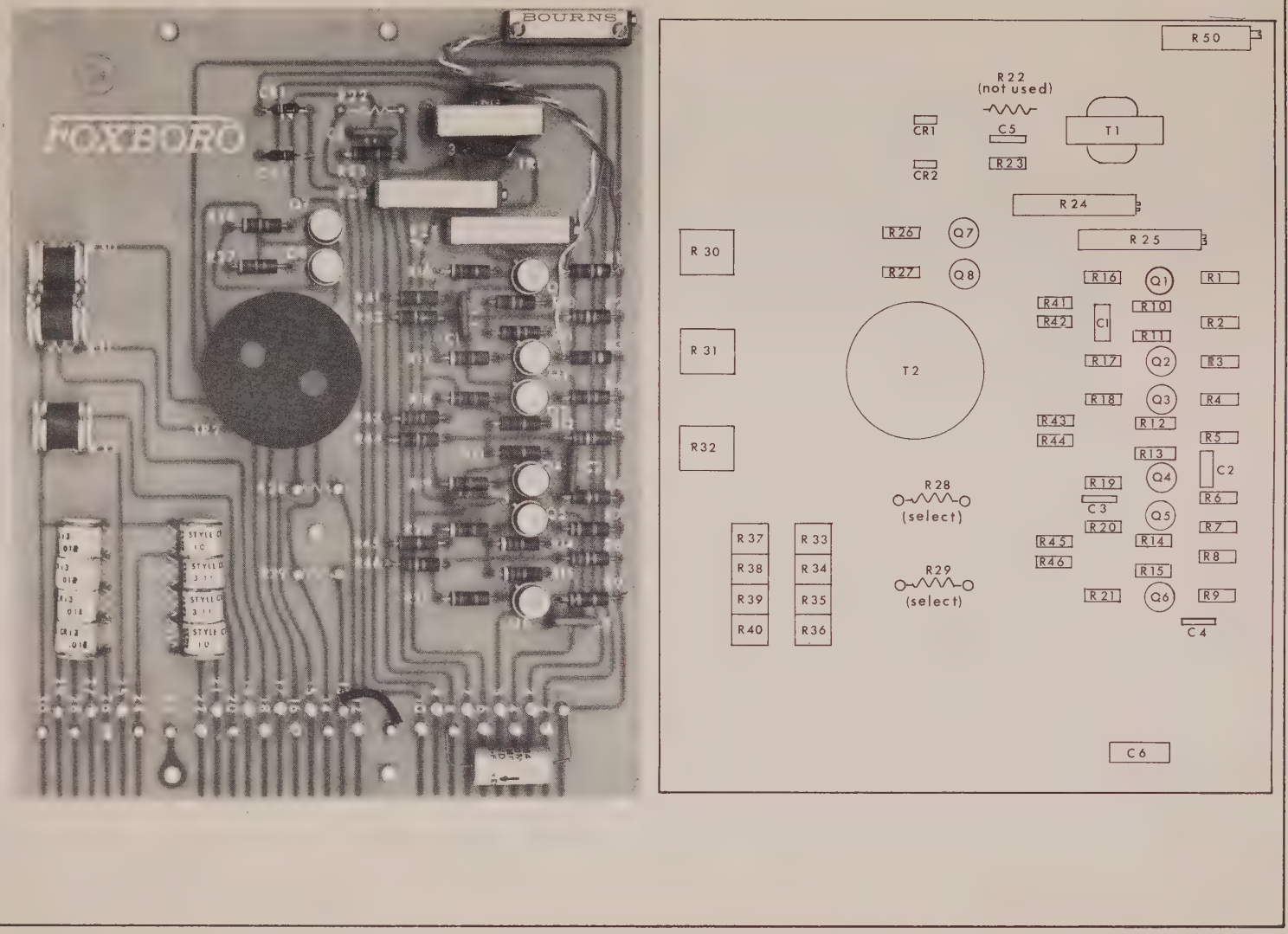


Figure 6-2. Amplifier

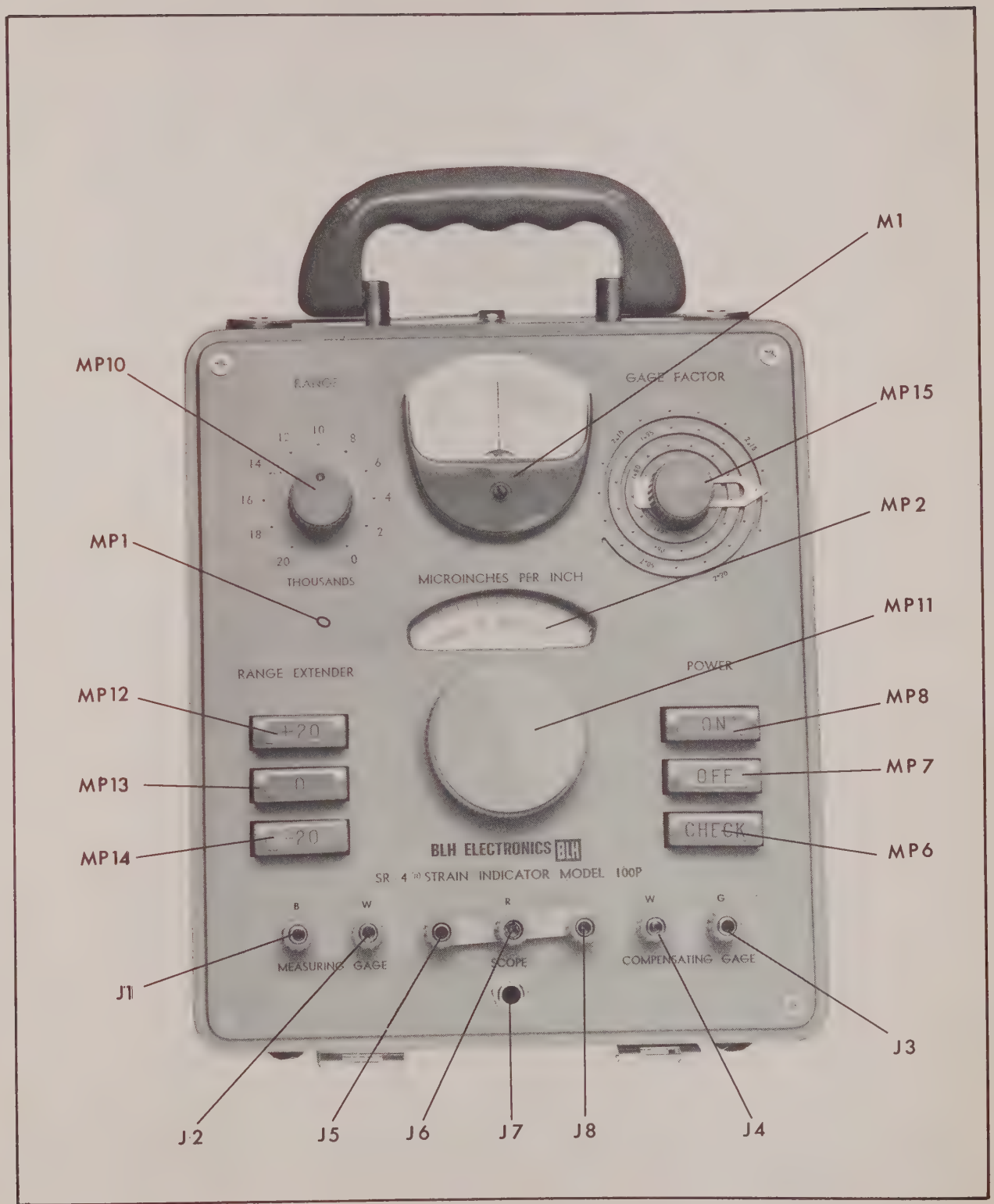


Figure 6-3. Front Panel

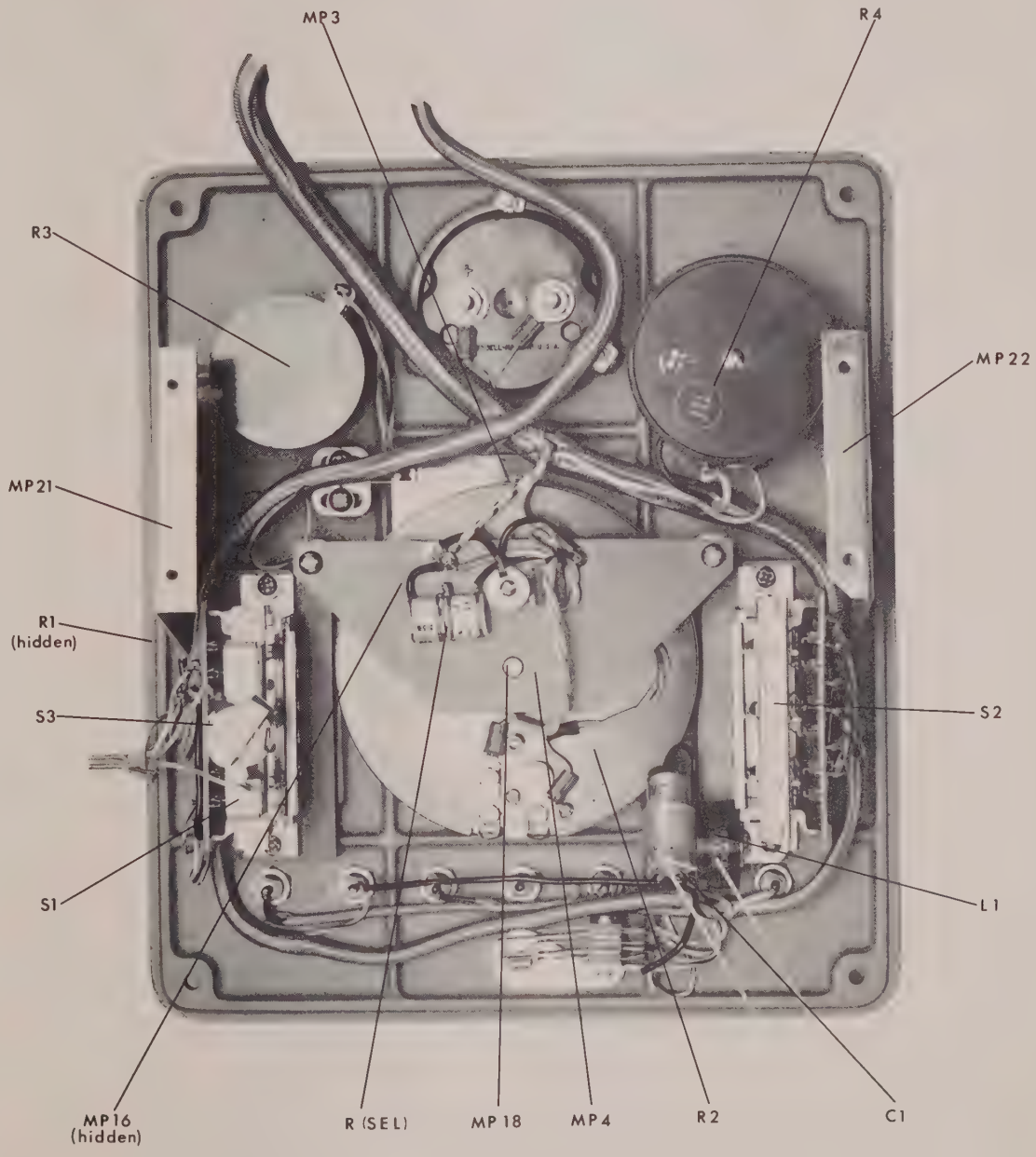


Figure 6-4. Front Panel (Rear View)

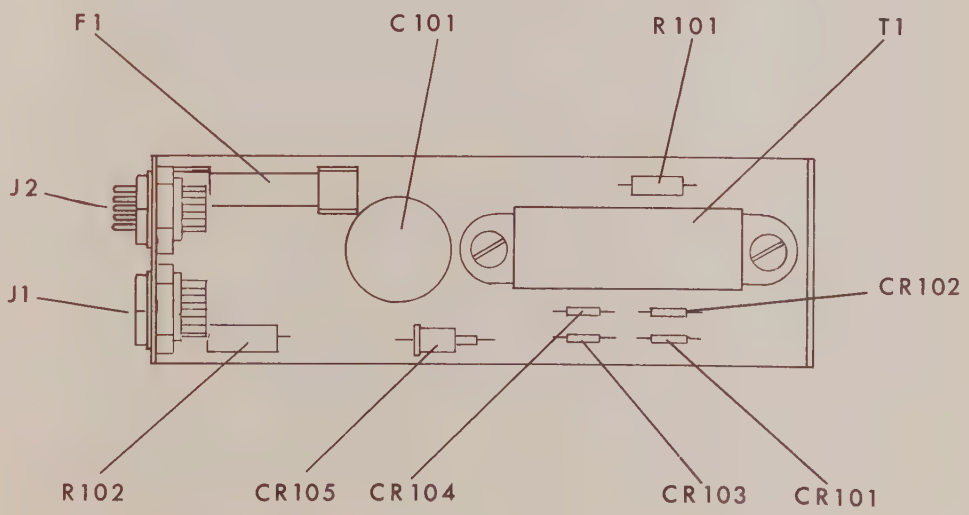


Figure 6-5. 100PA Power Supply

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TWX: 910-588-3284

BLH Electronics Div.
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